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Canadian Aeronautical Journal

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1909 1959

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Golden Anniversary of FLIGHT IN CANADA

Published by the
CANADIAN AERONAUTICAL INSTITUTE
Commonwealth Building, 77 Metcalfe Street
OTTAWA

First 50 years of powered flight in Canada

1909 1959 Golden Anniversary of FLIGHT IN CANADA

1909–1959

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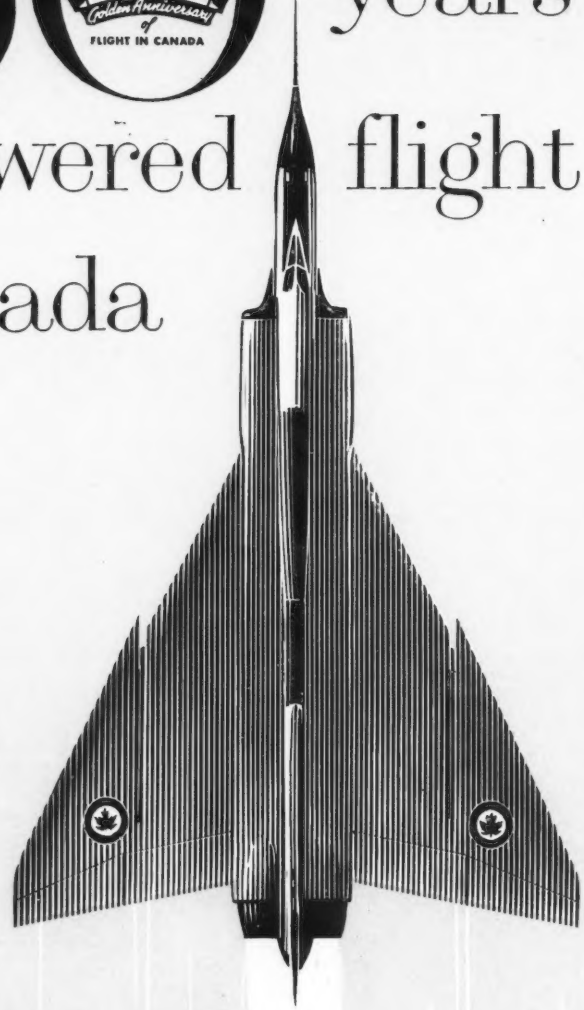

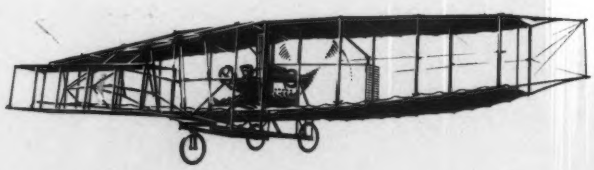

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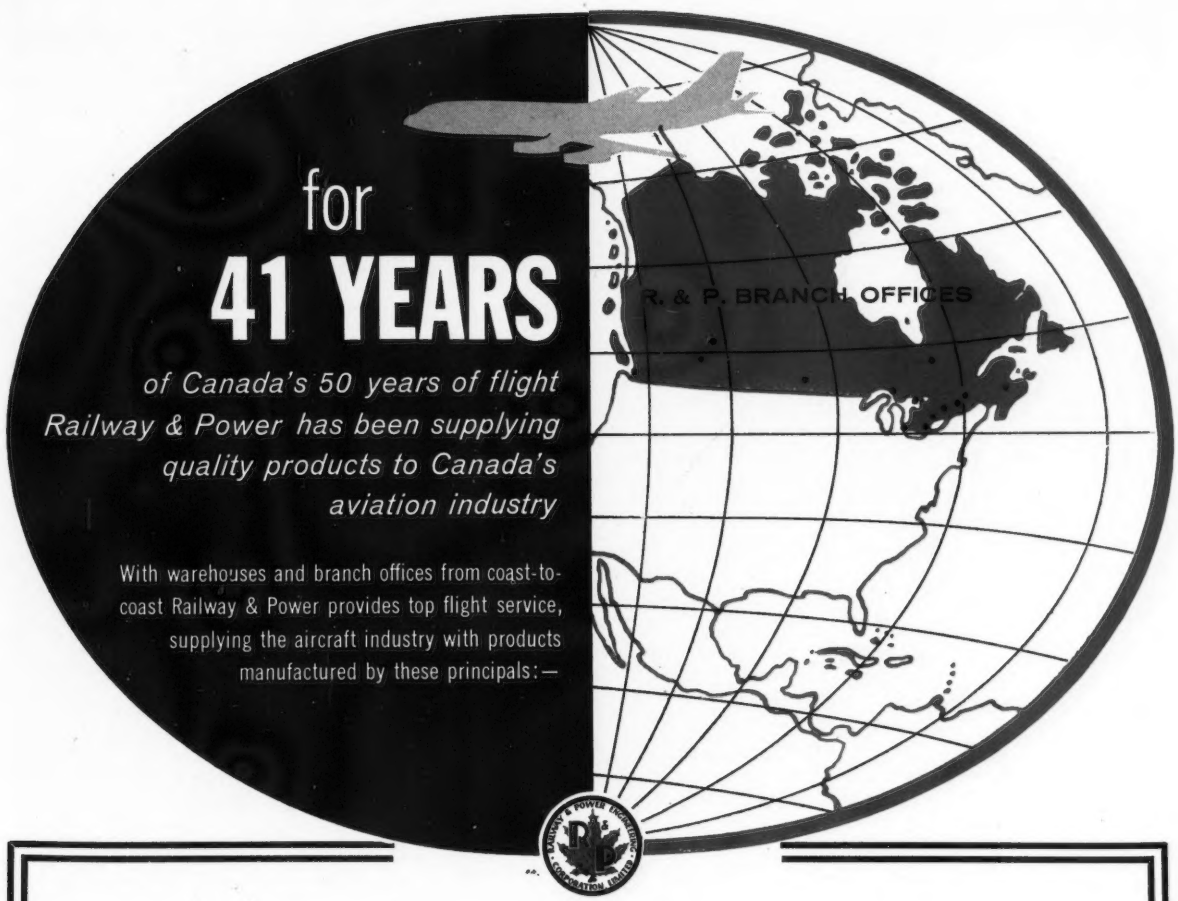

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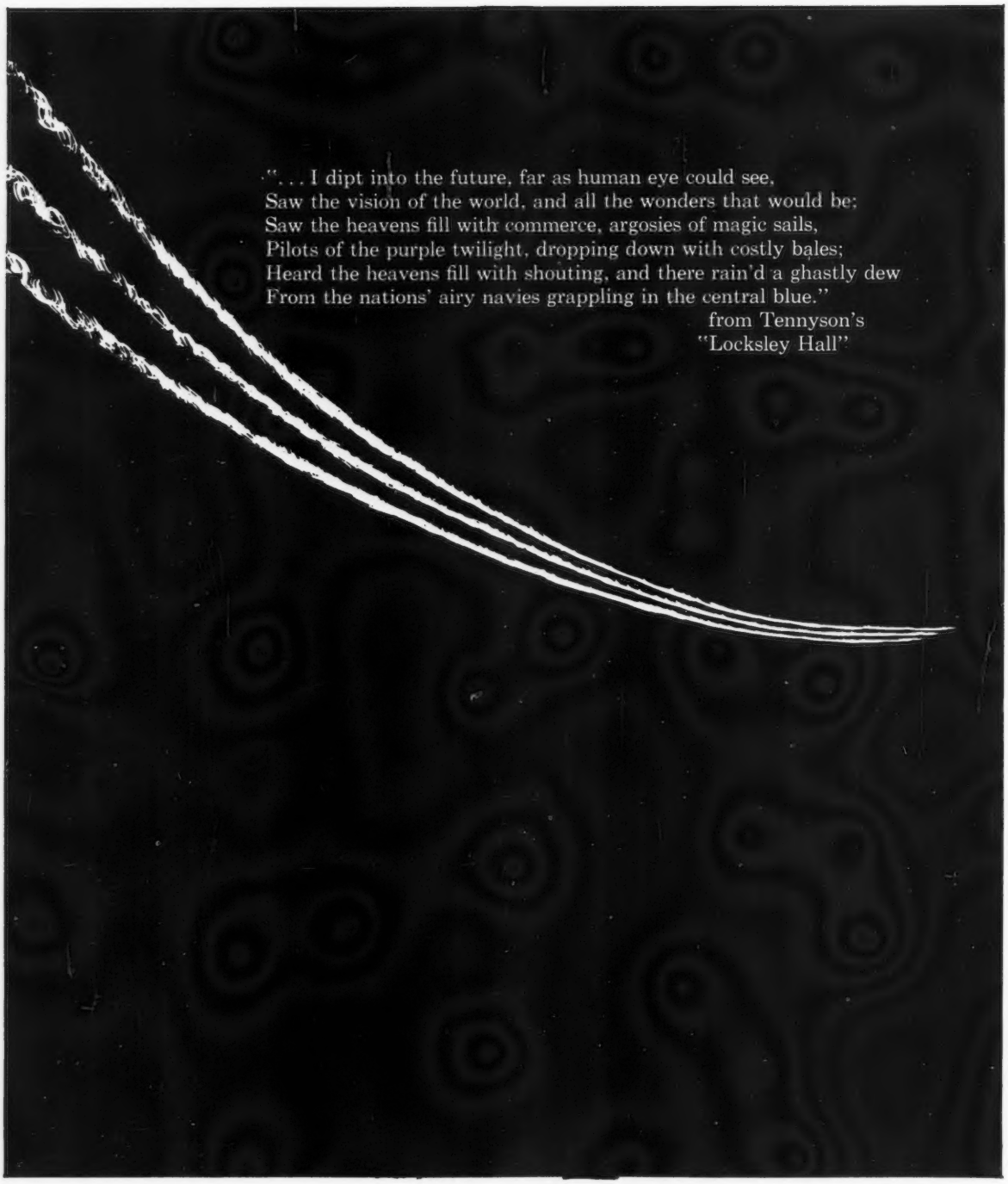
". . . I dipt into the future, far as human eye could see,
Saw the vision of the world, and all the wonders that would be;
Saw the heavens fill with commerce, argosies of magic sails,
Pilots of the purple twilight, dropping down with costly bales;
Heard the heavens fill with shouting, and there rain'd a ghastly dew
From the nations' airy navies grappling in the central blue."
from Tennyson's
"Locksley Hall"

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SOME CANADIAN AIRCRAFT ENGINEERING MILESTONES

The first 50 years have seen many instances where Canadians have pioneered in world aviation. Here are but a few examples.

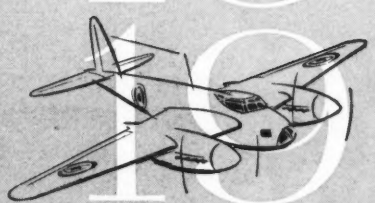
1909

First flight of The Silver Dart. Considering the absence of precedence, and the hazards which were instinctively overcome, this was indeed a major achievement.

1924

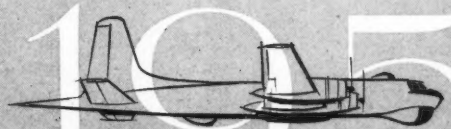
First Canadian-designed aircraft, the Vickers Vedette, produced in Montreal. The Vedette did first arctic aerial photography, and was so generally useful that some were still in service at the beginning of World War II.

1942-45



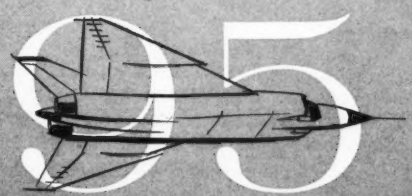
Production of many important aircraft including plywood Mosquito bombers for World War II. Many hydraulic components for these Canadian-built aircraft were supplied by Jarry.

1957



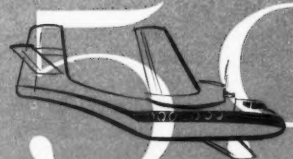
Production of first CL-28, largest aircraft ever built in Canada. A complete re-design of Bristol Britannia by Canadair. Landing gear by Jarry.

1958



Production of first Avro CF-105, the world's fastest interceptor. World's first high temp/pressure hydraulic-powered controls, and nose gear by Jarry.

1959



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"There shall be wings! If the accomplishment be not for me, 'tis for some other."
LEONARDO DA VINCI (1452-1519) genius of the Renaissance, who wrote the first treatise on the mechanism of flight in 1505.

And the "wings" came for Canada on February 23, 1909, when J. A. D. McCurdy flew the "Silver Dart" for Alexander Graham Bell's Aerial Experiment Association and its five original members. Its first flight was for half a mile at 40 miles an hour at Baddeck, N.S.

In the 50 years since, Canada has become one of the world's foremost air powers. Her aircraft manufacturing plants rank third in employment, and ninth in value of dollar output. Canada's airmen gained distinction in two World Wars; and her airlines rank fourth among all nations in passenger-miles flown annually.

The future of aviation in Canada is as limitless as the potential of our young and vigorous nation. In so many realms of national activity—transportation, exploration, defence—Canada will use the air with ever increasing effectiveness.

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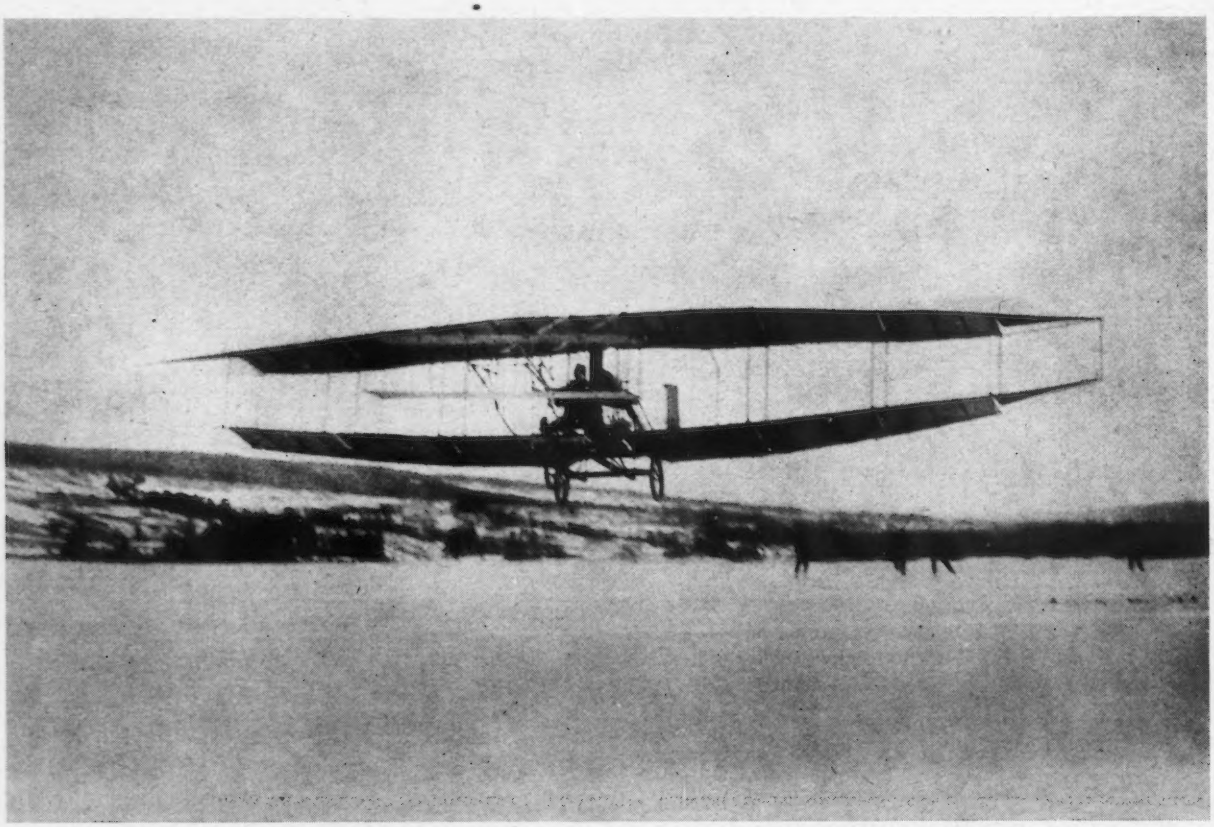
THE SILVER DART



Photograph by H. M. Benner,
Courtesy and Copyright National Geographic Society

The Silver Dart taking off on its historic flight from the ice of Baddeck Bay, Lac Bras d'Or, N.S.

EDITORIAL

THE SILVER DART

I HAD spent 16 years of my youth with the Bells in an atmosphere of inventiveness. On finishing university in Toronto and receiving my degree in Mechanical Engineering in 1907, I asked F. W. Baldwin, a student friend of mine, to come home with me to Baddeck. There, one evening, Mrs. Bell suggested to her husband that perhaps he could employ two young engineers in a positive way. We reviewed where to concentrate our efforts. Dr. Bell had been interested in flying machines for a long time and it was decided that our objective would be to build a powered, manned flying machine.

What did we know about flying machines? We had reference books prepared in laboratories, such as Langley's on surfaces and pressures, Bell's own work on centres of pressures related to centre of gravity, and we had our recently acquired university knowledge in mechanical design, stressing and materials.

Our programme was, firstly, to build an initial flying machine and with experience to develop it to overcome any deficiencies, and, secondly, to train ourselves in the art of flying.

In our approach we had Bell's guiding principle, that unless one failed, one could not succeed.

We first built a box-shaped glider for a man to hang on and gained some flying experience by gliding it off small mountains in the area of Hammondsport, N.Y. Balance was obtained by swinging the body. This was not good enough, so we put outriggers on and a flat tail, and managed to glide a good hundred yards. It worked, so we decided to put it together as an aircraft.

Our group then consisted of Bell, Baldwin and myself, and we brought in Lieut. Selfridge and Glenn Curtiss, who was a builder of motorcycle engines.

Our work was carried out at Hammondsport, N.Y., and was based on an understanding of mechanics rather than mathematics. We knew that fish-shaped bodies minimized resistance in water, so we applied this principle to all struts and beams. The structural design was empirical. We tapered the wing thickness with span as the load decreased, and we tested various parts of the structure and joints by applying sizable loads to these and assuring they did not fail prior to being assembled.

For our engine we linked 8 motorcycle cylinders together on one crankshaft. We built a propeller of tubes with metal sheet riveted on. We ran the engine with the propeller on a block to see that they would function.

We were great believers in trying things, so we put the machine together, took it out and flew it.

This first machine had tubular runners and was taken off from ice. On its second hundred yard flight it toppled over due to lack of lateral balance. Our second machine was built to have better lateral control by putting movable surfaces on the trailing edge of the wing which were linked to shoulder yokes carried by the pilot. As he was tipped in either direction, he would automatically, by his body movement, control these surfaces – now called ailerons.

The second machine had a tricycle undercarriage with the steerable front wheel linked to the rudder control. This machine which had made flights of up to 1,300 ft was cracked up due to pilot error. With the experience gained, we built our third machine – the June Bug. In this machine we made many successful flights – over one mile on July 4, 1908 – and in the same machine I made the first figure eight to have been flown anywhere in the world, which proved the machine's manoeuverability.

We had used the same air cooled engine in all three machines. The engine had not been damaged in the two crackups but in the third machine on a cold flight it seized.

We then built a liquid cooled engine and our fourth machine – the Silver Dart. This was mostly built at Hammondsport and then brought to Baddeck for final completion and the first flight on February 23, 1909.

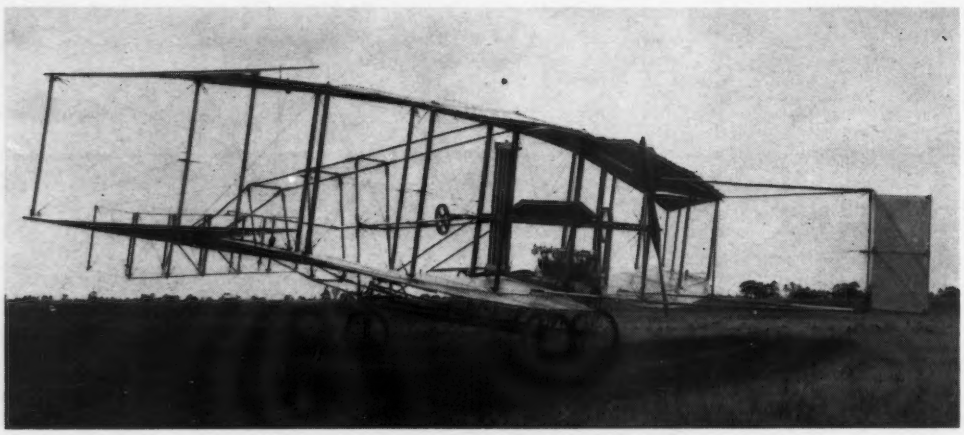
For our flight we had the background and development of three previous machines and I had completed more than 100 flights before February, 1909.

In two years we had advanced from a decision at Baddeck to fly a powered machine to the first powered flight by a British subject in the British Commonwealth.

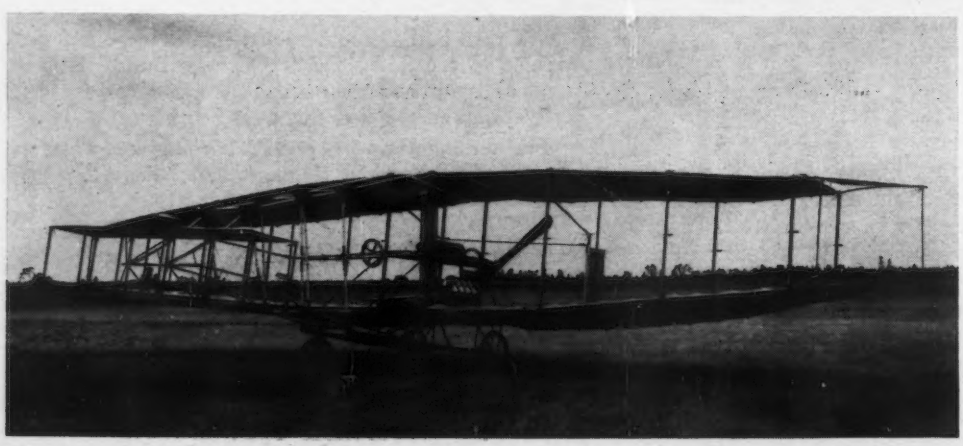
What made this possible? We built on experience as it was gained and got on with the job, for one can easily spend too much time thinking and never get around to doing.

J. A. D. McCURDY

RCAF FULL SCALE MODEL



These photographs show the full scale, flying model of the Silver Dart, recently built by the RCAF. On the right, the Hon. J. A. D. McCurdy at the controls with LAC L. G. McCaffrey, who was primarily responsible for the project.

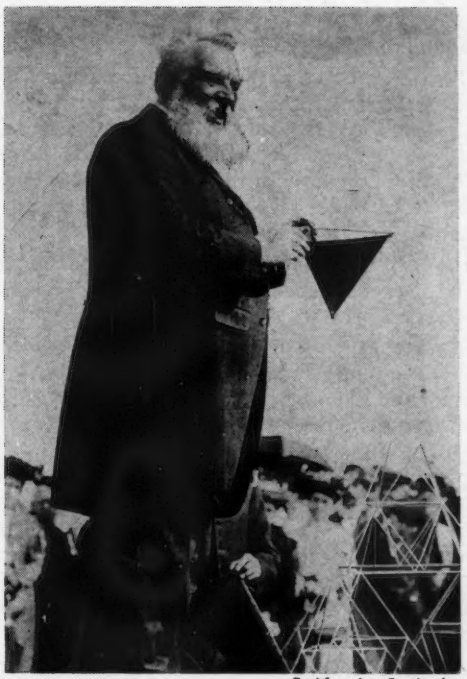


THE EVOLUTION OF THE SILVER DART

by J. H. Parkin

FIFTY years ago, on 23 February, 1909, J. A. D. McCurdy, in the Silver Dart, made the first powered flight in Canada at Baddeck, N.S., and the first such flight in the British Empire by a British subject. The flight was the culminating achievement of the Aerial Experiment Association.

This unique, illustrious, North American group of five, headed by Dr. Alexander Graham Bell and founded, inspired and financed by Mrs. Bell, made notable contributions to man's final accomplishment of mechanical flight; contributions out of all proportion to its short existence, size and resources.



Smithsonian Institution

Dr. Alexander Graham Bell and a tetrahedral cell

MULTICELL KITES

Dr. Bell, perhaps best known for his work for the deaf and as the inventor of the telephone, had from boyhood been fascinated by the possibility of mechanical flight. He made many thousands of experiments bearing on the subject and, eventually, in his search for a safe, stable and efficient flying machine concentrated on kites. He believed that a properly constructed kite should be capable of powered flight and that a properly designed flying machine could be flown as a kite.

As kite after kite was flown from the windy slopes of Beinn Bhreagh, his estate at Baddeck, there gradually emerged, about 1901, the tetrahedral cell as the basic structural and aerodynamic (winged) unit[a]. Continuing his experiments, the cells were combined in increasing numbers in larger and larger multicell kites until, in 1905, his 1,300 cell Frost King inadvertently raised a man from the ground, and satisfied him that an aerodrome[b], not unduly large, was capable of supporting a man and powerplant in a moderate breeze.

He was convinced that the multiple winged cells with their limited centre of pressure movement and dihedral provided the stability on which he insisted and that operation off water assured safety during the critical takeoff and landing operations. These advantages, in his view, outweighed the disadvantages of the large size resulting from their inferior supporting power and their high air resistance. He proceeded, then, to prove his views experimentally by building such a machine.

To this end he began assembling materials and resumed his experiments on aerial propellers which he had begun earlier. He also began to investigate the aerial propulsion of floats. As early as 1903 he had begun experimenting with floats adapted for propulsion over water and to serve as the body of the flying machine in the air – the original conception of the flying boat. It led later to Dr. Bell and Baldwin developing hydrofoil craft.

Dr. Bell soon realized that for the design and construction of aerodromes of the size he envisaged, he lacked the engineering knowledge required. Most opportunely, that summer (1906) J. A. D. McCurdy, returning home after completing his senior year in engineering at the University of Toronto, brought with him his classmate F. W. (Casey) Baldwin, who had just graduated. McCurdy's father had served Dr. Bell for years as secretary, assistant and photographer on his kite experiments, and McCurdy had grown up in an atmosphere of kite flying experiments. Casey, having read Chanute's "Progress in Flying Machines", had become interested in mechanical flight and was keen to meet Dr. Bell and see his work.

Dr. Bell was glad to show the young engineer his kite experiments and to outline his problems. Casey's interest and enthusiasm apparently impressed Dr. Bell and he invited Casey to join him as an assistant. Casey returned to Baddeck in the fall and lived there for the rest of his life.

[a]His standard cell had a side of 25 cms, about 10", and the winged cell had two faces covered with silk, forming triangular wings at a dihedral of 70°.

[b]Dr. Bell had adopted Langley's term aerodrome instead of aeroplane.

A year later Casey and McCurdy were joined by Lieutenant Thomas E. Selfridge, a young officer in the U.S. Field Artillery and another flying machine enthusiast. Seeking practical experience he approached Dr. Bell in Washington. Dr. Bell was interested and wrote the U.S. President requesting that Selfridge be detailed to observe his experiments.

In his search for a motor for his kite aerodrome, Dr. Bell learned that Glenn H. Curtiss was designing and building motors for dirigibles in his motorcycle shop in Hammondsport, N.Y. Dr. Bell ordered a motor and was eventually successful in persuading Curtiss to join him as the engine expert.

The little group now numbered five, the mature Bell and his young associates, Baldwin, McCurdy, Selfridge and Curtiss. They formed a happy, enthusiastic coterie. Living and working together, Bell, the master, was stimulated by the enthusiasm of the young men and they were spurred on by the vigorous, versatile, inquiring mind of the genius.

Mrs. Bell, observing their eager activities during the day and lively discussions in the evening, suggested that they should form an association which she offered to finance. The proposal was welcomed enthusiastically.

After thorough discussion a formal agreement was drawn up and signed, bringing into being on 1 October, 1907, for a period of one year the Aerial Experiment Association, for the purpose of achieving mechanical flight by the construction of a practical man-carrying, power driven aerodrome. Mrs. Bell provided a sum of $20,000 to finance the operations and Dr. Bell placed his laboratory at Beinn Bhreagh at their disposal. Dr. Bell was named Chairman, Baldwin Chief Engineer, McCurdy Treasurer and Assistant Engineer, Selfridge Secretary, and Curtiss Director of Experiments.

Cygnet I

The first project undertaken by the Association was the construction of Dr. Bell's tetrahedral cell aerodrome. It had a span of 42.5 ft, contained 3,393 cells, and mounted on three floats weighed 208 lb (see Table 1 for detailed dimensions). It was completed early in December and in accordance with Dr. Bell's views was flown as a kite over water. Towed on a catamaran tender behind a local steamboat it took off, flew well and, when released, landed gently on the water. Four days later, on 6 December, 1907, with Selfridge on board as observer, it rose some 168 ft in the air, then, as the wind dropped, it subsided gently, and, shrouded in smoke from the steamer, settled unobserved on the water. Before the tow rope could be cut, it was wrecked beyond repair. Selfridge dived overboard with the records and was unhurt.

BIPLANES AND CYGNET II

At the post mortem that evening opinion was divided as to the merits of the tetrahedral construction. However, it was agreed that they should build a machine similar to that being experimented with elsewhere, and also a Chanute type glider on which to acquire flying experience. At the same time, Dr. Bell adhered to his plans for a powered tetrahedral cell aerodrome and immediately put in hand the fabrication of the thousands of cells required.

TABLE 1

AERODROMES — TETRAHEDRAL CELL OF THE AERIAL EXPERIMENT ASSOCIATION

Number	–	5
Name	Cygnet	Cygnet II
Sponsor	Bell	Bell
Span — max, metres	13	16
feet	42′ 6″	52′ 6″
cells	52	64
min, metres	10	12
feet	32′ 10″	40′ 0″
cells	40	49
Chord, metres	3	4
feet	10′ 0″	13′ 0″
cells	12	16
Area, sq metres	184	200
sq feet	1975	2152
No. of cells	3393	3690
Construction	52 x 12 x 12	64 x 16 x 16
Elevator — span, metres	–	3.75
feet	–	12′ 0″
— chord, metres	–	0.65
feet	–	2′ 2″
— gap, metres	–	0.71
feet	–	2′ 4″
Rudder span	–	4′ 0″
chord	–	2′ 0″
Weight, machine, kg	94.5*	183
lb	208	400
powerplant, kg		183
lb	–	400
pilot, kg		68
lb	–	150
Total, kg		430
lb		950
Completed	1 December, 1907	19 February, 1909
First trial — date	2 December, 1907	22 February, 1909
— pilot	unmanned**	McCurdy

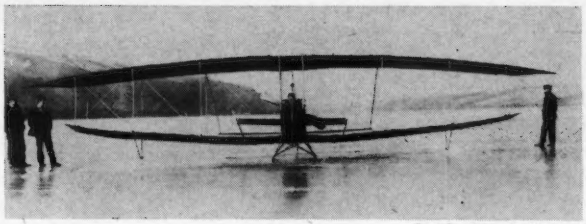
*including floats.
**on second flight, 6 December, Selfridge was aboard as observer.

It was also decided that their base of experiments should be transferred to Hammondsport for the winter, where the weather conditions were less severe and other facilities were available. Here gliding began early in January and in some 50 glides from a nearby hill the young associates acquired the "feel of the air" during the two months that the glider lasted.

As experience elsewhere indicated that flying machines did not long survive, they anticipated building a number of machines and, further, recognized that confusion and delay would result from group control. They therefore agreed that each machine in turn should be in charge of one associate; it would be regarded as his machine and he would have final approval of the plans, but all the associates would contribute to its design. Selfridge was chosen unanimously to be the sponsor of Drome No. 1 in recognition of his ducking in the Cygnet.

The associates possessed among them a good deal of specialized knowledge, together with above average native ability, and had the benefit of the mature guidance and experience of Dr. Bell. After studying the limited literature available, including the writings of Chanute, Langley, Lilienthal, Hargraves and Zahm and the published details of the machines actually flying in Europe, they adopted the biplane configuration for their first machine. They were then face to face with the major problem, the provision of lateral stability and control, in which machines then flying were deficient (except the Wright machine, on which no information was available).

In the biplanes of Santos Dumont, Farman, Bleriot, Esnault-Pelterie and Voisin, lateral stability, if any, was elementary and provided by vertical fin surface. Lateral balance, destroyed by a gust, was restored by turning into the wind. Consequently, machines were normally only flown when there was little or no wind, from smooth hard ground, usually a parade square, and in a straight line. Only on 13 January, 1908, did Farman succeed in winning the Deutsche-Archdeacon Prize for a flight of 1 km in a closed circuit.



Smithsonian Institution

The Red Wing

Red Wing

In Drome No. 1 the Aerial Experiment Association achieved a measure of longitudinal stability by means of the so-called "longitudinal dihedral" between wings and tail surface, and by using a wing section of reversed curvature shown by Turnbull to possess inherent stability. Any lateral and directional stability was provided by the vertical fin area of the interplane struts and rudder. Vertical control was provided by an elevator – a pivoted flat surface, ahead of the wing – and horizontal control by a vertical rudder at the middle of the rear tail surface. These were controlled by levers operated by the pilot's left and right hands respectively.

Because the machine was covered with red silk, as used by Dr. Bell to improve the photography of his kites, it was christened "Red Wing".

The Red Wing incorporated several novel features demonstrating the ability of the associates and the influence of Baldwin. Because of his engineering training and familiarity with Chanute's book, Casey had emerged as the structural engineer of the group. He had introduced the "bow-string truss", instead of the usual Pratt truss, to compensate for the lateral weakness of the streamlined interplane struts and, as a result of its bowed wings, Red Wing differed strikingly from the rectangular configuration of its contemporaries. The wings were of unequal span, the upper wing having the greater span, with straight leading edges and tapering in plan form to a point at the tip.

Lilienthal had shown that such a plan form had increased aerodynamic efficiency and lateral stability and facilitated turning. The curvature of the wing section decreased toward the tips, i.e. there was washout of camber. The ribs were of laminated spruce and ash.

Probably as a result of experience with the Cygnet, reduction of head resistance was constantly in mind and all exposed struts were "fish shaped".

As it was planned to fly the Red Wing in the winter, it was mounted on two runners to operate off the ice of a nearby lake. The pilot was shielded from the wind by covering with silk the rectangular nose supporting the elevator.

The powerplant comprised a Curtiss 8 cylinder air-cooled 50 hp V motor driving direct a pusher propeller constructed of sheet steel blades between radial steel tubes.

Dimensions are given in Table 2.

When completed early in March, Selfridge was absent and, as melting of the ice on Lake Keuka rendered any delay hazardous, Casey was chosen to make the trial. Watched by many spectators he climbed into the cockpit, the propeller was spun, Red Wing began to move, gained speed and, after a run of 100-150 ft, lifted, slowly climbed and flew steadily for some 300 ft at a height of about 10 ft before failure of a tail strut forced her down. The flight, made on the first attempt, without prior experience, measured 319 ft, the longest first flight of any such machine.

Thus F. W. (Casey) Baldwin on 12 March, 1908, made the first public flight in a powered heavier-than-air machine in America and became the first Canadian to fly such a machine. He was probably the ninth man to pilot an aeroplane in flight.

On its second flight a few days later, with a biplane tail replacing the single surface and again piloted by Casey, the Red Wing dropped one wing tip, slid off the wind and crashed, a casualty of the prevalent inadequate lateral stability and control.

Careful consideration was at once given to the lessons to be derived from the Red Wing. Casey had reported on the flights to Dr. Bell in Washington and Dr. Bell, replying on 20 March, 1908, recommended that attention should be concentrated on improving inherent lateral stability and he suggested movable surfaces at the wing tips operated by the instinctive movement of the pilot through a shoulder fork. In a machine such as the Red Wing the triangular wing tips, if hinged along the leading edge and operated differentially, would provide lateral control and might be used in turns. Here was the original suggestion for the aileron.

Alternatively Dr. Bell suggested varying the area of the wing tips. He also suggested the provision of shock absorbers and more freedom of movement for the pilot. A further suggestion was that a model of any machine should be made and flown as a kite and that sufficient fin surface should be provided to enable it to fly as a kite.

Chanute suggested that the wings should be reversed to make the leading edge curved, which is the idea of the raked or swept wing appearing for the first time. Casey, as a yachtsman, appreciated the value of what he called slanting or curved cutting edges on both aerodromes and hydroplanes in reducing resistance and agreed that what are now called swept wings and positive stagger might improve efficiency and possibly fore and aft stability. The idea was not adopted in the Aerial Experiment Association machines but later was used by Casey in his hydrofoils.

White Wing

Work began immediately on Drome No. 2 to be sponsored by Casey. Because the supply of red silk was practically exhausted, the wings were covered with white cotton and the machine was christened "White Wing".

TABLE 2

AERODROMES — BIPLANES OF THE AERIAL EXPERIMENT ASSOCIATION

	1	2	3	4
Number	1	2	3	4
Name	Red Wing	White Wing	June Bug (Loon)	Silver Dart
Sponsor	Selfridge	Baldwin	Curtiss	McCurdy
Started	Jan. 1908	18 Mar., 1908	24 May, 1908	10 July, 1908
Wings — span	43′ 4″*	42′ 3″	42′ 6″	49′ 0″
— chord, max	6′ 3″	6′ 6″	6′ 6½″	6′ 0″
min at outer struts	4′ 0″	4′ 0″	4′ 5″	4′ 0″
— gap, max	6′ 6″	6′ 6″	6′ 6½″	6′ 0″
min at outer struts	4′ 0″	4′ 0″	4′ 1″	4′ 0″
— incidence	7½°		8°	9¼°
— area, sq ft	385.5	408.5	370	420
Tail surface — span	14′ 10″**	10′ 0″	10′ 0″	–
— chord	3′ 0″**	2′ 3″	2′ 4″	–
— gap	single**	2′ 3″	3′ 0″ – 2′ 4″	–
Elevator — span	8′ 0″	9′ 0″	11′ 0″	12′ 0″
— chord	2′ 0″	2′ 6″	2′ 6″	2′ 2″
— gap	single	single	single	2′ 6″
Rudder, vertical — height	4′ 0″***	2′ 3″	3′ 0″	4′ 0″
— chord	4′ 0″***	triangle	3′ 0″	2′ 0″
Ailerons — span	–	4′ 0″	4′ 0″	5′ 1½″
— chord	–	4′ 0″	4′ 5″	4′ 0″
Engine Type	8 cyl. V	8 cyl. V	8 cyl. V	8 cyl. V
Bore stroke	3⅝ x 3¼	3⅝ x 3¼	3⅝ x 3¼	3¾ x 4
Cooling	air	air	air	water
hp rated	40 @ 1800 rpm	40 @ 1800	40 @ 1800	50 @ 1600
hp cruising	25 @ 1200	25 @ 1200	25 @ 1200	
Propeller type	metal	spruce	spruce	wood
dia	6′ 2″	6′ 2″	6′ 2″****	8′ 0″
pitch	4′ 0″±	6′ 2″+	6′ 2″+	6′ 3″
static thrust	130 lb @ 1000	245 @ 1200	245 @ 1200	
weight, lb	15	8	8	8¼
drive	direct	direct	direct	chain 16:10
Weight, airframe	185	238	266	345
powerplant	200	192	207	225
water fuel oil tank	–	–	–	140
pilot	185	175	142	150
Total	570	605	615	860
Completed	early March	before 14 May	19 June	1 October ex engine
First flight date	12 March, 1908	18 May, 1908	21 June, 1908	6 December, 1908
distance	300 ft	279 ft	485 ft	600 ft
pilot	Baldwin	Baldwin	Curtiss	McCurdy
Destroyed date	17 March, 1908	23 May, 1908	–	2 Aug., 1909
pilot	Baldwin	McCurdy	–	McCurdy

*Upper wing, span of lower wing about 37′ 4″.
**After first flight changed to biplane tail 10′ 0″ span, 2′ 3″ chord, 2′ 3″ gap.
***Later reduced to 2′ 3″ x 2′ 3″.
****Later cut down to 5′ 11″ diameter.

In configuration the White Wing closely resembled her predecessor but the construction was somewhat heavier and there were important differences in detail.

The most important innovation was the introduction of the hinged wing tips for lateral control, as suggested by Dr. Bell. As designed by Casey, the triangular tips of both wings were hinged along their leading edges. Normally aligned with the adjacent wing, the tips were deflected differentially through a shoulder fork, tiller and cables, by the pilot leaning instinctively to the high side. A patent[c] was subsequently issued to the five associates covering, among other features, "lateral balancing rudders", i.e. ailerons.

Vertical control was increased by use of a larger elevator, farther forward, operated by axial movement of the steering wheel. The box tail used to remedy the structural weakness of the original single surface tail of Red Wing was retained on White Wing. The surfaces were the same size, in the same location, but set at an incidence of 20°20′ so that wings and tail were at the angle of maximum L/D in horizontal flight.

The rudder located between the tail surfaces was triangular and operated by a steering wheel as in a motor car.

The construction of the wing trusses was improved by fitting all members with end sockets, those of the interplane struts being threaded to permit adjustment of the wire cross bracing without use of turnbuckles.

For operation on land the White Wing was fitted with a tricycle undercarriage with pneumatic bicycle wheels. This was the first wheeled undercarriage in America. In the original undercarriage, the two front wheels were castoring and the single rear wheel, under the tail, fixed.

The same engine as in the Red Wing was used, but fitted with a laminated spruce propeller.

During the first trial of White Wing, piloted by Selfridge on 14 May on the Hammondsport race track, the wing tips fouled the raised edges of the track and the grass infield proved too rough. The height of the undercarriage was therefore increased, and it was reversed, the single nose wheel being made castoring and the two rear wheels fixed.

Tried again by Selfridge on 17 May, the rudder proved inadequate for ground control and the under-

[c]U.S. Patent 1,011,106 filed 8 April, 1909, issued 5 December, 1911.

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The White Wing

carriage was made steerable by fitting the front wheel with fork and tiller.

Next day, after a ground run of 200 ft during which the steerable undercarriage functioned well, Casey made a short hop of 279 ft at a height of 10 ft. Descent was forced when the air pressure deflected the trailing edge of the lower wing enough to foul the propeller. Selfridge made short flights of 200 and 240 ft next day, the second being witnessed by Dr. and Mrs. Bell. Both were much impressed.

Curtiss made his first flight on 21 May, flying 615 ft touching down momentarily and continuing for a further 400 ft, during which the effectiveness of the lateral control was demonstrated by steering to right and left. Two days later McCurdy made his first flight of 549 ft. New to the controls, he failed to use the ailerons to counter the effect of the quartering wind, the machine tipped, one wing touched the ground and she somersaulted. The damage was so extensive that it was decided to salvage what was usable and start on the third machine.

June Bug

Drome No. 3 was to be sponsored by Curtiss. In size and general configuration it too was much the same as its predecessor. Specifically with respect to White Wing, No. 3 incorporated the following changes.

The ailerons, when undeflected, were set at zero incidence instead of at wing incidence. It was reasoned that, when set at wing incidence, a deflection downward of one aileron increased the drag of that aileron more than the drag of the upwardly deflected aileron was increased, which resulted in a yawing moment requiring rudder deflection to correct. However, deflecting both ailerons equally from neutral caused equal increases in drag and no yawing moment, thus eliminating any need for rudder control to maintain a straight course[d].

The longitudinal position of the loads was increased and longitudinal control again increased by increasing the elevator size and moment arm. Lateral control was augmented by fitting a square rudder hinged aft of the biplane tail. The surfaces of the latter were bowed similarly to the wings.

The wings were made easily removable from the centre section and the wing cell strengthened by guy wires to the undercarriage frame and wheel axles.

The covering of the nose supporting the elevator was abandoned to improve the pilot's vision.

The same engine and, initially, the White Wing propeller were again used. Switch and spark controls were mounted on the steering wheel.

The steerable tricycle undercarriage was lengthened and strengthened by heavy horizontal members serving as skids, when, as not infrequently happened, wheels were wiped off.

It was agreed, after the experiences with the first two machines, that Curtiss only should pilot Drome No. 3, to profit from the experience acquired from repeated flights.

No. 3 was completed on 19 June and given a trial run, without wings, to test the undercarriage. Next day three unsuccessful attempts were made. Porosity of the wings was suspected, and the cotton was painted with wax dissolved in gasoline. In an attempt to increase thrust the propeller diameter was reduced 3 inches, the speed increasing as a result from 1,050 to 1,200 rpm.

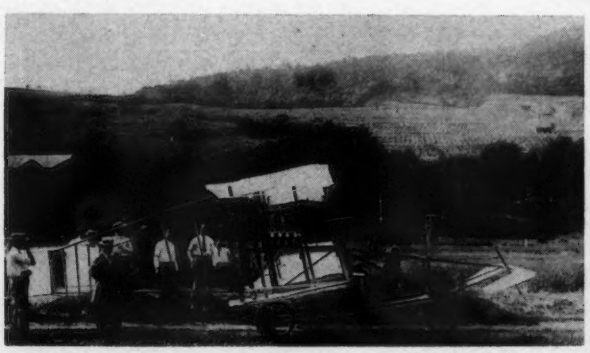
On 21 June, Curtiss made three flights of 456, 417 and 1,266 ft respectively. Witnessed by Dr. and Mrs. Bell the flight of the machine reminded Dr. Bell of a June bug and, on his suggestion, Drome No. 3 was christened "June Bug".

The aileron control on June Bug proved effective but longitudinal and directional control were inadequate and were increased by fitting a larger elevator and rudder and by moving the pilot's seat forward.

On 4 July, 1908, the June Bug, piloted by Curtiss, won the Scientific American Trophy for the first flight of one kilometer in a straight line, when it flew nearly 6,000 ft and afterwards made an S turn before landing.

The winning of the Trophy was a significant event in the history of aviation and had interesting repercussions. It was the first official test of an aeroplane in America and only two other machines, the first two Voisin biplanes, had flown in public a greater distance. Farman had made a record flight of 2,004.8 metres on 21 March, 1908, and Delagrange on 11 April had flown 3,925 metres.

Dr. Bell immediately had his patent attorneys examine the machine for patentable features, and after witnessing a flight of the June Bug on 7 July, they reported that the ailerons, the shoulder movement for their control, the tricycle undercarriage and the combination of steerable ground wheel and rudder were, in their opinion, patentable. They were instructed to draft applications.



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The June Bug

[d]This was a vital point in refuting the claim of the Wright brothers that the Aerial Experiment Association machine infringed their patent.

The same month Curtiss received from Orville Wright the opening letter in the lengthy patent litigation which was to ensue, claiming that the June Bug infringed the Wright patent No. 821393. Dr. Bell was greatly disturbed. His bitter experience with the telephone patent and his personal integrity made it essential that the Association position be irreproachable. He had suggested the movable wing tips without prior knowledge of the Wright development simply because of the close secrecy they had maintained on all their work and he pointed out the crux of the matter – that the Wright patent covered joint use of wing warping and rudder to correct the induced yaw, whereas no rudder action was necessary in the June Bug because the aileron action induced no yaw.

Silver Dart

Dr. Bell, en route from Washington to Baddeck following the Trophy flight, suggested that to avoid the delay between the crash of a machine and the construction of its successor Drome No. 4 to be sponsored by McCurdy should be started at once. As McCurdy was anxious to get on with his machine, he accepted the suggestion with delight and immediately started on No. 4. He incorporated, as usual, the lessons learned from her predecessors in his machine.

Curtiss continued flying June Bug, making his 19th flight on 26 July before leaving for Washington to instal an engine in the Signal Corps Dirigible No. 1. Thereafter McCurdy and Selfridge made numerous flights in which they established that the Curtiss engine was incapable of operating at full power for more than 90 seconds before overheating caused the power to fall off. This had only become apparent when they began to make flights of a mile or so requiring about 1½ minutes. Curtiss admitted that the engine was, in effect, oil cooled rather than air cooled. In consequence McCurdy demanded that a water cooled engine, similar to that built for the dirigible, should be installed in his Drome No. 4. They agreed on an 8 cylinder V water cooled engine, to have a rating of 50 hp at 1,600 rpm, which Curtiss optimistically estimated would weigh 175 lb and could be built in three weeks.

As work proceeded on No. 4, Curtiss and McCurdy continued experimenting with June Bug.

The curvature of the ribs of June Bug, as a result of frequent wetting, had relaxed and, as McCurdy was considering the use of ribs of single curvature for his No. 4, new laminated ribs of single curvature were made and tried successfully on June Bug. It was thought that under air pressure the rear portion of the Turnbull reflexed profile flexed further and increased the drag seriously, whereas similar flexing of a single curvature profile would produce a reflexed curvature of moderate drag.

The tail of June Bug was arranged to fold to facilitate housing in a shed.

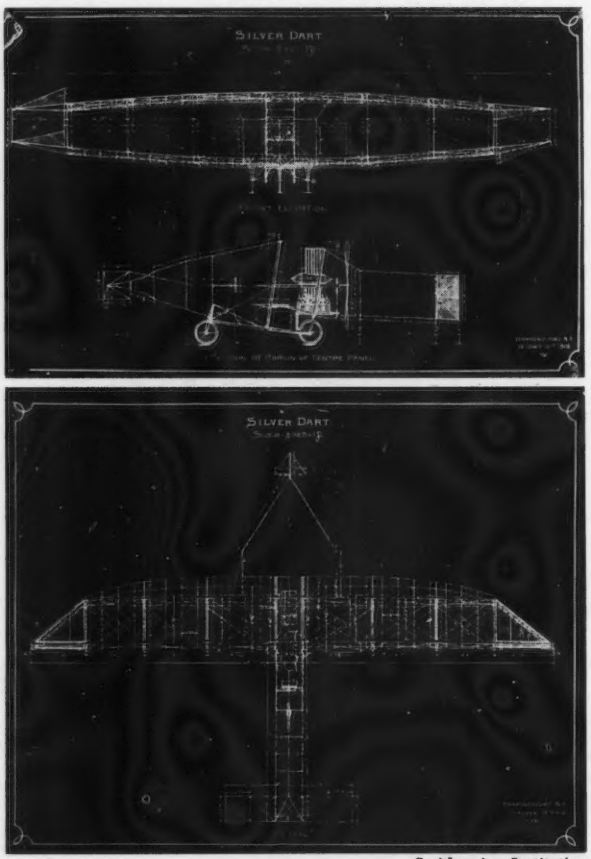
Attempts were made to improve the cooling of the engine to permit longer flights and a larger propeller was fitted.

They proved that with the larger elevator mounted farther forward the rear tail planes were unnecessary and, indeed, June Bug handled better without them.

As they expected to fly at higher speeds and in stronger winds with Drome No. 4, a biplane elevator was tried on June Bug to further increase control.

Finally, on 29 August, McCurdy flew a two mile figure eight in 3 minutes and Curtiss, two days later, flew a circle in 2 minutes 28 seconds.

Drome No. 4 was ready for the engine toward the end of September. With the experience gained in building her predecessors, the standard of workmanship, precision and finish of the parts were greatly improved and the machine was quite a professional job although it had, in consequence, taken longer to build than the others.



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Drawings of the Silver Dart

No. 4 was rather longer and heavier and its configuration differed from its precedessors in having a biplane elevator in front and single vertical rudder only in the rear. The wings were of equal span and the structure of the wing cell was improved. Ribs of steel tubing were used at panel points instead of struts, single wire bow-string trusses were used, and the lateral chords (spars) and interplane struts were of spruce and of heavier streamline section. The struts were fitted with end sockets and, to permit individual tensioning of the cross bracing, turnbuckles were again used instead of the screw ends. The centre section was built as a unit and was much stronger. The construction permitted each of the four wings to be handled as a separate unit. The

laminated ribs were of single curvature, decreasing from a maximum camber of 3½ inches to 2 inches at the tips, and were inserted in pockets in the covering. The incidence was increased to 9¼° corresponding to 6° in level flight.

The wing covering was a non-porous rubber faced silk, weighing 2 ounces per square yard. The silver finish of the cloth prompted McCurdy to suggest that No. 4 be named "Silver Dart".

All controls were strengthened. The aileron span and area were increased and they were double surfaced. The rudder, though slightly smaller, was rectangular instead of square and hence more effective. The biplane elevator was larger and farther forward, as tested satisfactorily on June Bug.

The tricycle undercarriage was similar to that of June Bug but heavier and of better construction.

Early in August Selfridge had been ordered to Washington, transferred to the Signal Corps and appointed to the Aeronautical Board for the trials of Dirigible No. 1 and the aeroplanes being built by the Wrights and Herring. During the trials of the Wright machine at Fort Meyer, Selfridge volunteered to fly with Orville Wright in the passenger carrying test. In this test on 17 September the machine, following failure of a propeller, stalled and crashed. Both men were injured, Selfridge so seriously that he died that night.

The causes of the disaster were carefully examined by the Associates. Dr. Bell, in particular, prepared an exhaustive analysis. He concluded that side by side propellers were to be avoided; that co-axial contrarotating propellers, preferably driven by two engines, should be used; that all controls should be in front and thus visible to the pilot at all times, or a rear view mirror used; that the dive, which almost invariably followed the stall, resulted from defective balance of the machine at low speed, i.e. a too forward position of the centre of gravity (a trend unfortunately evident in the Aerial Experiment Association machines); that the machine should be in balance at zero speed because the nose up tendency at speed would then be controllable by elevator action and that controls should be larger and at larger moment arm.

He pointed out that in machines so far produced the safety and comfort of the pilot had received little attention. Dr. Bell observed that the large span and length of machines coupled with the fragile construction constituted an element of safety for the pilot in that, following impact, say, of a wing tip, the ensuing gradual crushing of the wing acted as a shock absorber. The man was saved at the expense of the machine. By increasing the strength to save the machine, the hazard to the pilot was increased.

Immediate results of Dr. Bell's analysis were the abandonment of McCurdy's proposal to use twin propellers on the Silver Dart and the prohibition by Dr. Bell of passenger carrying in the Aerial Experiment Association machines.

Eventually on 2 November the engine was completed and tested briefly, developing a static thrust of 300 lb. Each cast iron cylinder had a copper water jacket, concentric valves in the head (the inlet valve, initially, suction operated), auxiliary exhaust ports and individual carburettor; the crank shaft was of vanadium steel and the lubrication forced fed.

McCurdy insisted that the engine be capable of operating for one hour. To attain this involved much testing during which many mechanical, cooling and lubrication troubles were encountered and McCurdy was driven to suggest that perhaps they should use an automobile engine in the Silver Dart.

The original V belt transmission with two belts proved inadequate and was replaced by one with four belts. McCurdy, however, favoured a chain drive which involved making a whole new transmission.

Inspired by Casey's work on flotation at Baddeck, Curtiss and McCurdy, while waiting for the new engine, fitted light wooden floats on the June Bug, which, thus equipped, they dubbed the "Loon". During the construction of the chain transmission, they tried the Loon with the new engine but were unsuccessful in getting off the water and engine trouble continued. They then decided to try hydroplanes, with which Casey was experimenting.

In the meantime the engine was installed in the Silver Dart, driving, through the 16:10 chain transmission, a wooden pusher propeller. The engine was mounted practically on the lower rear spar to keep the centre of gravity low.

Despite the early work of Dr. Bell the design of propellers for their machines was a constant problem and they proceeded largely on a cut and try basis. It took them two weeks to arrive, in an experimental way, at a design for propellers for the June Bug. For the Silver Dart, initially, four wooden propellers and one of cast aluminum, of different designs, each 8 ft in diameter with 6 ft 3 inch pitch, were made and tried. Later a 7 ft diameter 8 ft 6 inch pitch wooden propeller was used with some success.

McCurdy made the first flights with the Silver Dart at Hammondsport on Sunday, 6 December, 1908. All were short; the first two terminated after about 200 yards, by water in the fuel tank; but the third permitted him to get the feel of the control, which was more sensitive than that of the June Bug. A fourth flight a few days later ended when a side gust caused a swerve which wiped off all three wheels. During repairs, other changes were effected, including fitting a heavier undercarriage to take the greater weight of the Silver Dart, replacement of the chain drive, which had proved disappointing, by the V belt drive, and the fitting of mechanically operated inlet valves to obviate the need to change the mixture after starting.

With these changes made, McCurdy on 14 December essayed a short flight and found the balance and control to his liking.

Engine troubles continued to plague them, however, and when just before Christmas Dr. Bell visited Hammondsport, McCurdy, much to his chagrin, was unable to get off. Dr. Bell concluded that the increased power of the engine only just compensated for the greater weight of the Silver Dart and left no margin.

Immediately after Dr. Bell's departure the Silver Dart was crated and shipped to Baddeck. The engine was again installed in the Loon, which, in the meantime,

had been fitted with cumbersome wooden hydroplanes. Early in January further unsuccessful attempts were made to takeoff, which terminated when a float was damaged and the Loon sank at the dock. The engine was then removed, reconditioned and shipped to Baddeck. It was early in February before the Silver Dart arrived, followed a few days later by the engine.

Cygnet II

To revert to Dr. Bell, following his return to Baddeck early in July, he threw himself energetically into the flying of models of his proposed aerodrome to determine the effectiveness of the interior cells, which Casey had questioned. The inefficiency of the interior cells being proved Dr. Bell ordered, on 21 August, the construction of his Drome No. 5, later designated "Cygnet II". Its configuration was similar to that of Cygnet I but of hollow construction, and it was somewhat larger. Details are given in Table 1.

Casey had returned to Baddeck about the same time as Dr. Bell, to assist him with his Drome No. 5. However, they developed ideas for a combination hydroplane-aerodrome type of machine and Dr. Bell placed Casey in charge of the development of this machine, designated Drome No. 6. In consequence Casey spent most of the summer developing flotation for this machine, during which he began to experiment with hydroplanes (hydrofoils). This was later to lead to the development of his successful hydrofoil craft.

The cell assembly of Cygnet II was completed by the end of October but the engine, of course, was not ready. While waiting Dr. Bell experimented with ¼ and ½ size models, flown as kites, to compare the performance of Cygnets I and II, and to test techniques of launching from the water.

However the delay in delivery of the engine and onset of winter forced abandonment of his plan to fly Cygnet II first empty, then with engine and man, off the water. Instead the trials had to be made off the ice under power and Cygnet II was accordingly fitted with steel runners and with biplane elevator and rudder, both in front; although Dr. Bell felt that with the great weight of the engine, twice that estimated by Curtiss, and of the additional structure to carry it, there was little hope of success.

On its arrival in Baddeck the engine was immediately installed in Cygnet II, driving through chain and sprockets a 10 ft diameter pusher propeller. McCurdy made the first trials on the afternoon of 22 February. The engine lacked power to drive the propeller at a speed adequate for takeoff and finally sheared the shaft.

FLIGHT IN CANADA

The engine was at once transferred to the Silver Dart and on the next afternoon, 23 February, 1909, the machine was run out on the ice of Baddeck Bay where a large number of people from the village had gathered.

On McCurdy's first attempt a gasoline line broke. After repair, a second start was made and Silver Dart ran some 100 ft over the ice, rose and flew about ½ mile at a height of from 10 to 30 ft and an estimated speed of 40 miles per hour before landing smoothly.

This historic flight, the first in Canada, was McCurdy's fifteenth flight. The names of over 100 of those present were duly recorded as witnesses.

Next day McCurdy made a circuit of about 4½ miles around the Bay at a height of 40-50 ft, during which he passed over a tree, but misjudged his landing and slightly damaged the machine. It was the best flight yet made by an Aerial Experiment Association machine.

Thereafter the engine was used alternatively in the Silver Dart and Cygnet II. Various modifications were made on Cygnet II in efforts to get her into the air but the best speed that could be attained was 15 miles per hour, quite inadequate for takeoff.

During March, numerous flights were made by McCurdy and Baldwin in the Silver Dart, despite practically continuous trouble with the engine. At one point Casey brake tested the engine and measured an output of 30 hp instead of the rated 50 hp. The end of winter, with the ice covered with water and slush, terminated the flying, the last flight of 3½ miles being made on 29 March.

In May, the Militia Department invited them to test the Silver Dart at the Petawawa military camp. With Dr. Bell's agreement, McCurdy and Casey had the machine crated and shipped to Petawawa where it was assembled and fitted with a Kirkham 6 cylinder water cooled automobile engine, developing on test an "easy" 40 hp at 1,700 rpm. Practice flights were made by McCurdy at dawn, on 2 August, 1909. The second flight was made with Casey on board as passenger and was the first passenger flight in Canada. On the fourth flight, again with Casey as passenger, McCurdy was blinded by the rising sun, the machine struck a knoll, turned over and was damaged beyond repair, McCurdy and Baldwin escaping with comparatively minor injuries.

The original one year term of the Aerial Experiment Association would have expired on 1 October, 1908. As the Associates were in Washington in September for the funeral of Selfridge, a formal meeting was held there at which advantage was taken of a generous offer by Mrs. Bell to provide additional funds up to $10,000, and the term was extended for a further six months.

The Aerial Experiment Association came to an end on 31 March, 1909, by time limitation. Organized for the specific purpose of achieving practical powered human flight, the Association proceeded systematically step by step, recorded its operations in detail, and was at pains to make known its successes and reverses. Each of the machines embodied lessons derived from its predecessors. The aileron proposed by Bell and applied successfully by Baldwin, the tricycle steerable undercarriage operated with the rudder, and the application of flotation to aeroplanes, instigated by Bell and developed by Baldwin, were important contributions at the dawn of aviation.

At its passing Dr. Bell wrote "The Aerial Experiment Association is now a thing of the past but it has made its mark upon the history of aviation and its work will live".

AIRCRAFT MANUFACTURING IN CANADA DURING THE FIRST GREAT WAR

by K. M. Molson

WHEN war was declared in August, 1914, there were no facilities existing in Canada for manufacturing aircraft. It was, in fact, almost a year later when the first factory was established and even then it was a comparatively small operation. Not until over two years later, in 1917, were aircraft placed in quantity production but, in spite of this late start, about 3,000 aircraft of 13 types were built in Canada before the end of hostilities.

Of all the aircraft produced, not one was purchased by the Canadian Government. This lack of interest is difficult to understand, particularly since immediately following the outbreak of war Canada purchased a Burgess-Dunne tailless biplane in the United States. This aircraft was flown to Levis, Quebec, where two army officers were detailed to accompany it overseas[1]. However, when it eventually arrived at its destination it was found to be damaged and consequently was never used. Following this unfortunate experience, the Canadian Government showed no further tangible interest in aviation until late in 1918 when it created Nos. 1 and 2 Squadrons of the Canadian Air Force. These squadrons were equipped with aircraft apparently loaned by the Royal Air Force.

The formation of the various aircraft companies in Canada together with a description of their products during the period of the first Great War are reviewed under their respective company headings.

CURTISS AEROPLANES AND MOTORS LIMITED OF CANADA

After the outbreak of war the young men of Canada soon found that the British Government would welcome them in the RFC and RNAS if they first acquired a pilot's licence. To obtain this licence they enrolled in American aviation schools at their own expense. Therefore, it was logical that the largest of the American companies should establish a Canadian subsidiary aimed primarily at pilot training.

The Curtiss Aeroplanes and Motors Limited of Canada was formed in 1915 and flight training commenced in the spring. To back up this operation a factory was established on Strachan Ave., Toronto, under the management of J. A. D. McCurdy. This was Canada's first aircraft factory and it was intended to provide new aircraft for the school as well as to repair the school's aircraft. However, it will be seen that the factory soon exceeded its originally planned role.

Early production consisted of Curtiss flying boats (Figure 1) and Curtiss JN training aircraft, but unfortunately there are no available records of the quantities produced. It is quite probable that they were few in numbers.

Figure 1
American built Curtiss flying boat

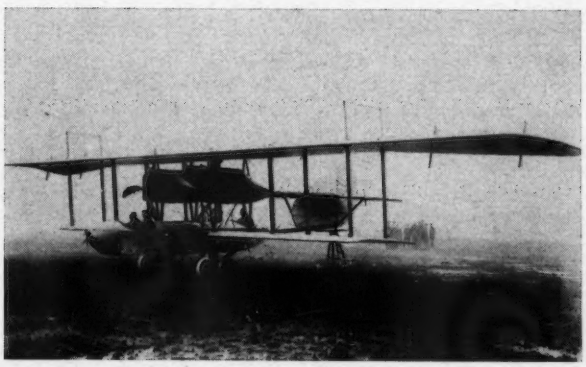

Figure 2
Curtiss Canada

The most interesting undertaking of the Canadian plant began in June of the same year and this was the design and manufacture of the Curtiss Canada or Model C (Figure 2). Its forerunner was a large twin-engined flying boat, designed by the parent company in 1914 at Hammondsport, N.Y., for a trans-Atlantic flight. This aircraft, which was named America, was considered to be quite successful and became the forerunner of a series of successful Curtiss flying boats as well as the F series of flying boats developed by Commander Porte at Felixstowe, England.

M. R. Riddell, Chief Engineer of Canadian Aeroplanes Limited, describes the development of the Canada in his paper[2] given to the Engineering Institute of Canada in February, 1919, and as both this aircraft and Mr. Riddell's paper are not well known today the following

paragraphs are quoted directly from his paper.

"While the outbreak of the war put a stop to the proposed trans-Atlantic flight, it was suggested that a large twin engined bombing plane along the lines of the "America" might be constructed. As the Hammondsport and Buffalo plants were crowded with other work, the working out of this new machine was entrusted to the Canadian plant.

"The original intention was to have the "Canada" as this machine was afterwards known, practically duplicate the "America" but with fuselage and landing gear instead of a hull, and two of the V.X. type 170 H.P. Curtiss motors instead of the smaller ones fitted in the "America". With these more powerful motors it was expected that a speed of 85 miles per hour would be attained as against the 60 miles per hour speed of the "America". Owing to these changed conditions, however it was found necessary to change almost every part so that the "Canada" as built was practically a new design throughout.

"Actual construction work was begun towards the end of June, 1915, and the first trial flight was made about the end of July. As there had been some delay in the delivery of the V.X. Motors intended for her, for this first trial she was fitted with two 90 H.P. motors similar to those in the "America". This first flight was successful, the "Canada" showing a speed of upwards of 70 miles per hour with these smaller motors, balancing and handling well.

"Some slight alterations were made as a result of this initial flight before she was again tried, this time with her proper motors. On this occasion she had a bad mishap on landing, and was partially wrecked. After repairs she was again tried and this time made a most successful flight, attaining a speed of better than 87 miles per hour with a climb of over 3,500 ft. in less than 7 minutes.

"As a result of this successful trial an order was placed by the British Government for eleven more machines of this type with certain modifications that had been found desirable.

"In the meantime the "Canada" had been shipped to England, where she underwent a series of further tests. On one of these tests after the motors had been "tuned up", and the stranded wire in the interplane bracing replaced by "stream line" wire of much lower resistance an average speed of 102 miles per hour was recorded.

"The "C" machines as these next eleven were known were in general similar to the "Canada" but embodied many refinements and improvements in arrangement and detail.

"These "C" machines were duly completed and shipped and work was started on a still further improved type to be known as the "C2", when instructions were received (in June 1916) to cancel the order for "C2" machines and stop all further work on the type."

While it has been stated elsewhere that the Canada was designed in the United States, Mr. Riddell's paper would appear to be the most authoritative source on this subject. Reference 3 states that Charles M. Manly, who had earlier designed the excellent radial engine for the Langley "aerodrome", "helped develop" the Canada. He apparently served in a consulting capacity. This could be considered as normal procedure, to have an experienced engineer act as advisor on the first design of the new company.

Figure 3
Curtiss JN3 of the RNAS

If we accept Mr. Riddell's statements, then the Canada becomes a milestone in the progress of Canada's aviation industry, being the first factory designed aircraft as opposed to the aircraft of the pioneers.

Mr. Riddell attributes the cancellation of the order by the British Government to difficulties with the Curtiss engines. However, it would appear probable that the development of the Handley Page 0/100, which began flight tests in January, 1916, also contributed to the cancellation. History does not record the fate of the last batch of eleven aircraft.

The somewhat meagre specification figures that are available on this aircraft are as follows:

Span—76 ft	Gross weight—7000 lb approximately
Crew—3	Military load—1000 lb approximately
Fuel—200 gallons	

The equipment in this aircraft was most advanced for an aircraft of this period and included an automatic stabilizer, the forerunner of the automatic pilot and a secret bomb aiming device[4], both of Sperry design.

During the peak of the Canada production, the Curtiss factory had employed 600 men, but after the cancellation the company had to exist on sub-contract orders from the Buffalo plant of the parent company. The working force was reduced accordingly. One order was for twenty fuselages which were completed at Buffalo as float seaplanes and supplied to the Spanish Government. Another order was for twelve complete JN3 training aircraft (Figure 3) which formed a part of a larger order which the Curtiss Aeroplane Company was filling for the Royal Naval Air Service.

At the beginning of 1917, the major portion of the Curtiss Aeroplanes and Motors Ltd. business, including the greater portion of the engineering and manufacturing staffs, was turned over to Canadian Aeroplanes Limited. However, the company survived until after the war as a supplier of parts and components for the Buffalo plant. The last aircraft order filled by this plant was for spare parts for F5L flying boats[2] in late 1918.

CANADIAN AEROPLANES LIMITED

A decision by the British Government to set up a flying training programme in Canada in late 1916 led to the establishment of the Royal Flying Corps, Canada.

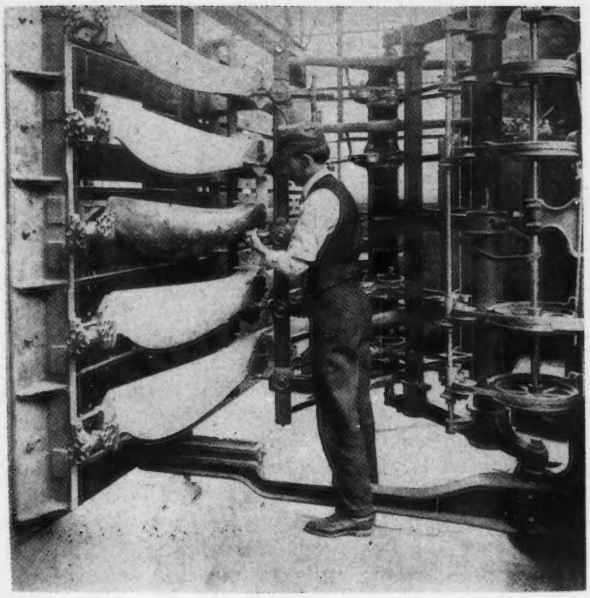

Figure 4
Propeller lathe at Canadian Aeroplanes Ltd.

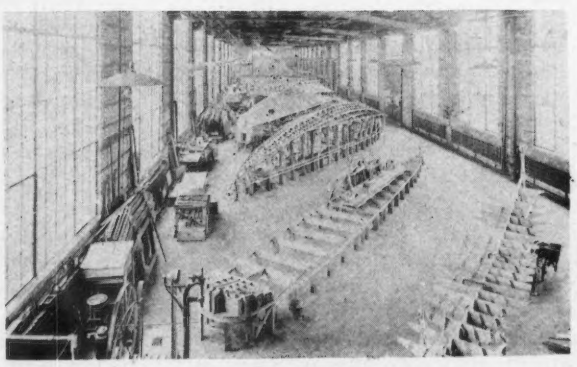

Figure 5
F5L hull assembly stages, Canadian Aeroplanes Ltd.

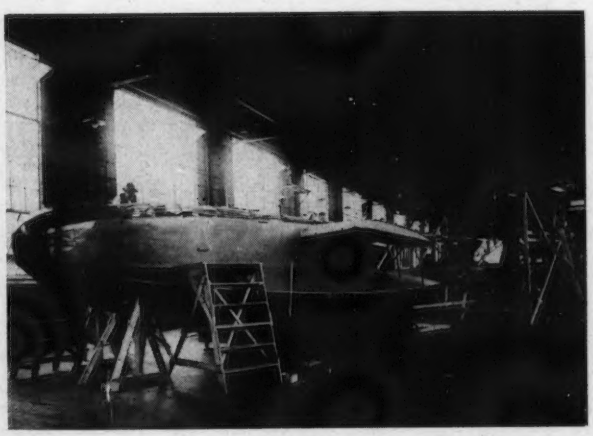

Figure 6
Final assembly of F5L hull, Canadian Aeroplanes Ltd.

To supply the force with training aircraft Canadian Aeroplanes Ltd. was created in December, 1916, under the direction of F. W. Baillie (later Sir Frank). The Chief Engineer at that time was F. G. Ericson who was succeeded in late 1918 by M. R. Riddell.

The manufacturing facilities of the Curtiss Aeroplanes and Motors Ltd. were acquired, but soon after work was commenced this accommodation proved inadequate and a contract was let in the last week of January, 1917, for a new plant of 235,000 sq ft to be constructed on Dufferin St., Toronto. These facilities, an impression of which may be gained from Figures 4, 5 and 6, were equipped to produce a complete aircraft with the exception of the engine, instruments and wheels.

The supply of raw materials was an item of great importance, and a special department was set up in Vancouver to assure a satisfactory supply of aircraft quality wood. Irish linen was imported for covering the first few aircraft but this was soon replaced by a high quality cotton from Wabasso Cotton Co.'s mills at Three Rivers, Quebec. A supply of engines was arranged from the Curtiss Co. in Buffalo.

The aircraft selected to be built for the training programme was a modified version of the Curtiss JN4 equipped with a 90 hp Curtiss OX5 engine. The main differences between the Canadian aircraft and the JN4D, the most common American model, were that the Canadian JN4 (Figures 7 and 8) had:

(a) a metal empennage in place of a wooden one which

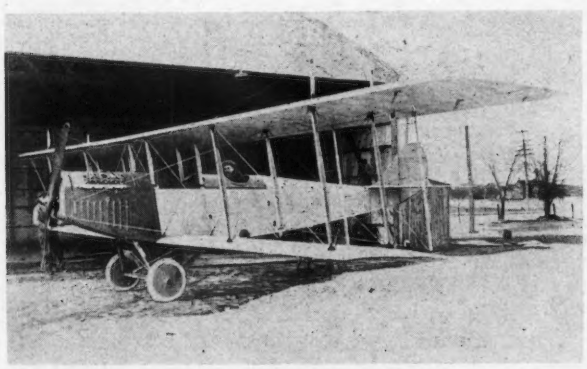

Figure 7
Canadian JN4 prototype

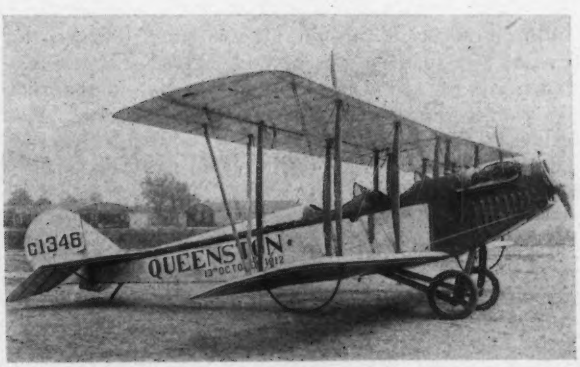

Figure 8
Canadian JN4 production model

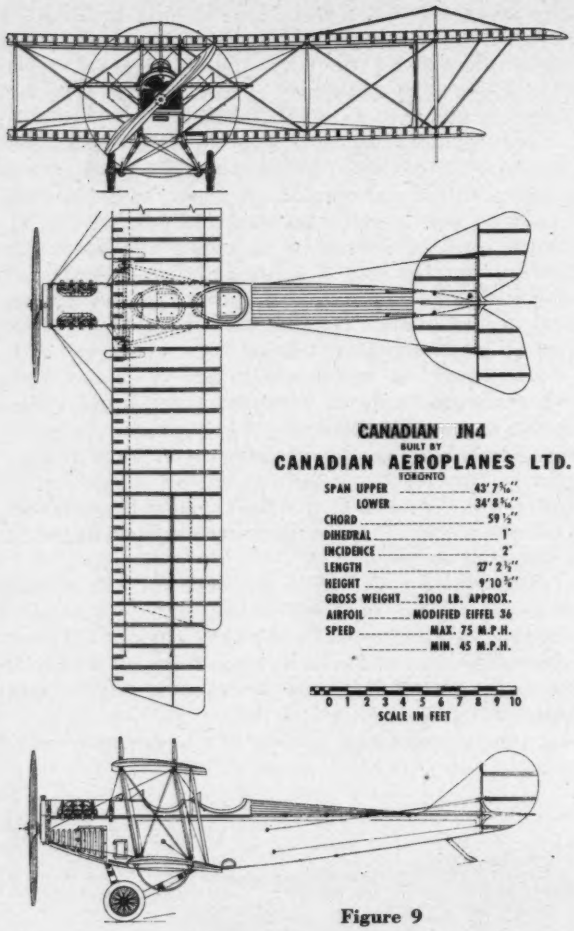

Figure 9

was of a different shape and, probably due to the stronger structure, external bracing wires on the rudder and elevator were not used,

(b) a thrust line parallel to the line of flight whereas the JN4D's thrust line was canted 6° down,

(c) ailerons on both upper and lower wings interconnected with a pair of struts,

(d) pointed tips on the lower wing which slightly increased the span, and

(e) a different aileron control system and the external aileron bracing wires were omitted.

In construction, this aircraft was quite typical of the period. The fuselage was of wire braced wooden construction with fabric covering and an aluminium cowling around the engine. The wings were also of wood and employed a conventional two spar construction. The undercarriage employed wooden members and the conventional rubber shock cord served as a shock absorber. Two minor changes took place during the production of the basic Canadian JN4. First, the two parallel struts, interconnecting the ailerons, which are seen in the illustration of the prototype, were soon replaced by the more familiar pair of Vee struts (Figure 9). This was followed by an enlargement of the cockpits and the addition of windshields[5].

Canadian Aeroplanes Ltd. referred to their standard production aircraft as a JN4 and a special version as the JN4A but both of these designations conflicted with different American models with the same designations. So it became known simply as the Canadian JN4 which the pilots and mechanics soon shortened to Canuck.

The Canadian JN4 was used for all types of military training in Canada. Its original role of elementary training was extended to include instruction in aerial photography, aerial gunnery both with machine guns and camera guns, and aerobatics. This was accomplished by devising suitable mountings for the guns and camera as shown in Figures 10, 11, 12 and 13.

In addition to those installations, the special version previously mentioned and known to Canadian Aeroplanes Ltd. as the JN4A was produced. In this model the pilot was moved to the forward cockpit and the rear cockpit was fitted with a Lewis gun on a Scarff mounting[6] (Figure 14). To counterbalance this modification the thrust line of the engine was canted downwards in similar manner to the American JN4D.

During the winter of 1917-18 the main body of the RFC in Canada was transferred to Texas as it was uncertain how training would be affected by Canadian winter conditions, but in order to obtain some experience, a small detachment remained in Canada to experiment with winter flying. This experiment proved successful to the extent that if another winter's operation had been necessary, the RFC would have remained in Canada. The development of skis for the Canadian JN4 (Figure 15) by Canadian Aeroplanes Ltd. with the cooperation of the 44th Wing of the RFC contributed in a large degree to the success of this experiment. Skis had been used in Europe at an earlier date, but this is believed to be their first use in Canada.

The summer of 1918 produced an ambulance version of the Canadian JN4 (Figure 16) which had an enlarged turtle deck aft of the rear cockpit in which a stretcher could be accommodated. It was hoped that, with this aircraft, personnel injured in training accidents in inaccessible places, and especially in the winter, could be brought quickly to receive medical attention. This aerial ambulance was never to see actual usage as the war terminated that fall. This concept of an aerial ambulance had been used earlier by the French who converted a Dorand biplane in a similar manner.

At least two aircraft were fitted with an additional fuel tank of cylindrical shape mounted above the centre section, and were used in air mail flights between Mont-

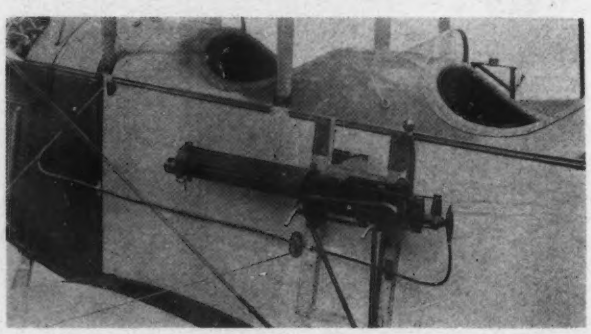

Figure 10
Vickers gun installation Canadian JN4

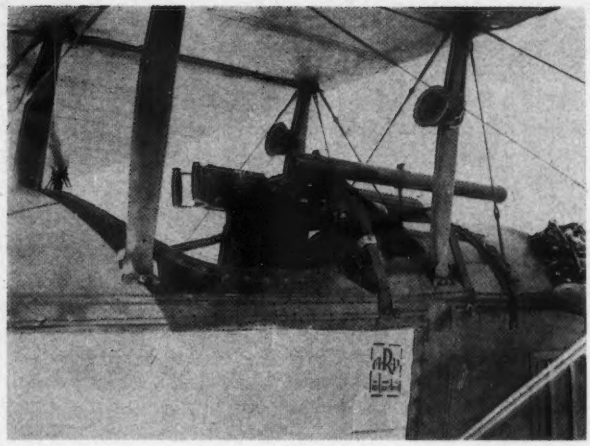

Figure 11
Vickers gun installation Canadian JN4

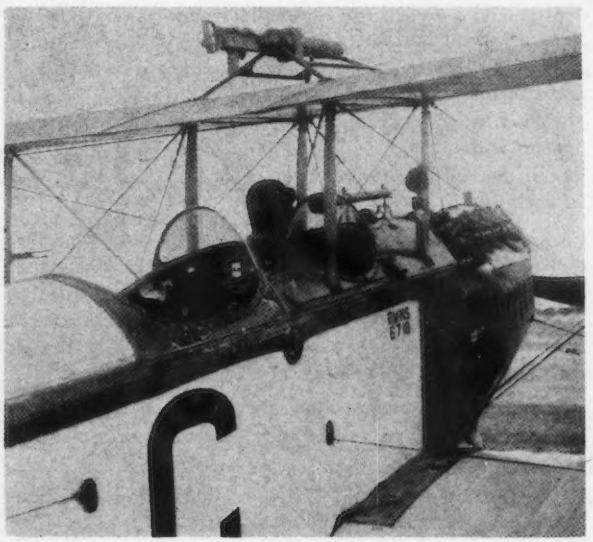

Figure 12
Camera gun installation Canadian JN4

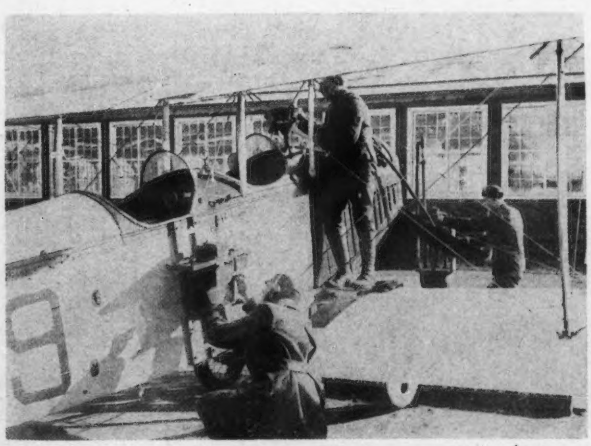

Figure 13
Camera installation Canadian JN4

Figure 14
Lewis gun on Scarff ring mounting on Canadian JN4

Figure 15
Canadian JN4 on skis

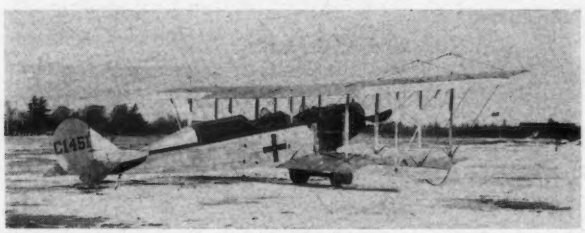

Figure 16
Ambulance version, Canadian JN4

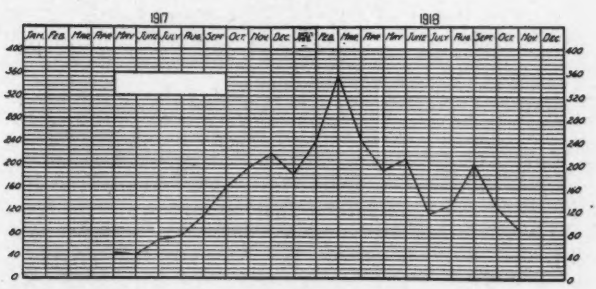

Figure 17
Monthly output of Canadian JN4 aircraft

real-Toronto, and Toronto-Ottawa in 1918. It is not known whether this was a modification installed by Canadian Aeroplanes Ltd. on special order or if it was a service engineered installation fitted for these flights only.

In all, 2,918 Canadian JN4 aircraft were produced, of which about 1,300 were delivered as complete aircraft, and the balance as spare parts. Of this total, 680 were supplied to the U.S. Government, beginning in September, 1917. Monthly production is shown in Figure 17.

Two postwar developments of the Canadian JN4 took place in Canada. One was the creation of a three place version by the F. G. Ericson Co. of Toronto. Mr. Ericson, who was the Chief Engineer of Canadian Aeroplanes Ltd. until late 1918, had set himself up in Leaside as Canada's first aircraft dealer, primarily to dispose of surplus Canadian JN4's.

In the Spring of 1919 he developed the Ericson Special Three[7], which appeared to be basically a Canadian JN4 with the fuel tank removed from the fuselage and an additional seat fitted forward in the front cockpit. A small cylindrical fuel tank was fitted above the centre section of the upper wing. It appears probable that this version was developed to compete with British three place Avro 504K's which were being imported by some operators. It is believed that its performance with three aboard was marginal, for it is recorded[8, 9] that it established a new "Canadian altitude record" of only 8,000 ft with three aboard on August 5th, 1919. One was flown in the Toronto to New York air race in 1919 by S. S. Moore who placed 3rd[10] in the Speed Contest and 4th in the Handicap Contest. It is believed that three of the Ericson Special Three's were built.

The other development was the manufacture of a single float installation for the Canadian JN4[10] in Vancouver in 1919 by the Hoffar Brothers who were acting as agents for the F. G. Ericson Co. This installation was very similar to that provided by the Curtiss Co. on the aircraft exported to Spain in 1916 and it is not known whether it was of original design or not.

It would not be fitting to conclude any story of the Canadian JN4 without a brief mention of its influence on postwar Canadian aviation and a few of its outstanding flights.

A summary report of July 2nd, 1920, issued by the Air Board lists 36 different firms operating aircraft and the types and numbers of aircraft operated by each are noted for 33 of them. Of the 44 aircraft listed, 36 are Canadian JN4's which gives some indication of the predominance of this type in early Canadian aviation. It is also interesting to note that one of the aircraft listed was owned by the Brandram-Henderson Co. of Montreal[11] and was probably Canada's first aircraft to be owned by a business firm as a convenience to its operation.

Notable flights accomplished by the Canadian JN4 include the following:

Flight	Place	Date	Pilot
1st Canadian air mail	Montreal-Toronto	June 24, 1918	Capt. Brian Peck
1st flight over Canadian Rockies	Vancouver-Calgary	August 7, 1919	Capt. E. C. Hoy
1st Canadian aerial survey	Alexis River, Labrador	July-August, 1919	Capt. Daniel Owen and W. F. Kenny

The story of the first two flights is adequately covered in Reference 12. The full story of the third flight remains yet to be told but a mention of it may be found in References 10 and 13.

From the above very brief record of the Canadian JN4 it can be seen that this aircraft not only was the first aircraft to be manufactured in quantity in Canada but also that it laid the foundations of our present air transport, business flying and aerial survey operations. It now must be recorded with regret that not a single specimen of the type is known to be in existence today in Canada to provide young Canadians with tangible evidence of the past. One or two specimens are believed to be in existence in the United States.

At the beginning of the Canadian JN4 programme, it was felt that in the event that difficulties should arise with the JN4, either in manufacture or in service use, an alternative aircraft should be available. For this purpose the Curtiss OX5 powered DH 6, a two seat primary trainer designed and built in England by the Aircraft Manufacturing Co. Ltd., was selected (Figure 18).

At that time the DH 6 was in general use as a trainer by the RFC in England. The original engine was the 90 hp RAF, but 90 hp Curtiss OX5 and 80 hp Renault versions were also made in England. It was designed with structural simplicity in mind which resulted in its angular and unprepossessing lines and also in the popular story of the time that its wings were made by the mile and cut off by the yard. The details of this aircraft and its British service have been ably presented in Reference 14.

For Canada, it is only of interest to note that one was completed in July, 1917, by Canadian Aeroplanes Ltd.[2] and successfully flown. However, as the Canadian JN4 was considered quite satisfactory, no more were made. This single DH 6 thus became the first British designed aircraft to be built in Canada.

While the Canadian JN4's performance was lauded[6] as being more than satisfactory, it was inevitable that progress would eventually make a replacement necessary. In the summer of 1918 the Avro 504K was selected to be the next standard trainer of the RAF, Canada. The British story of the 504K is fully covered in Reference 14 but it is fitting to provide a very brief review here.

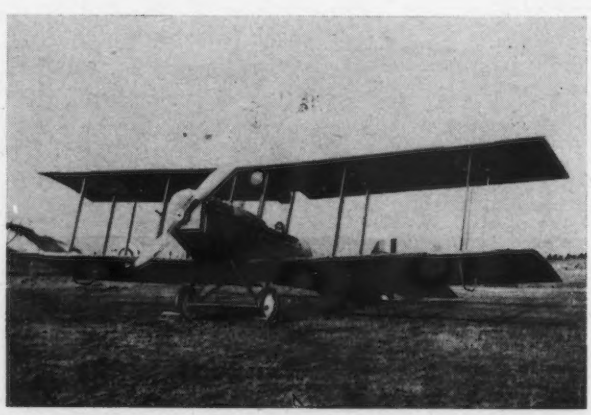

Figure 18
British DH 6 with Curtiss OX5 engine

The original 504 appeared in 1913 and was in advance of most of its contemporaries. When war broke out it was a standard service aircraft and its best known service exploit was the raid on the Zeppelin sheds at Friedrichshafen in November, 1914. Variants of the 504 appeared with various engines, and single seat versions for anti-Zeppelin patrols were produced. While it had been used for training earlier in the war, it was not until the Smith-Barry system of instruction was developed at Gosport that the 504 came into its own and was adopted as the RAF standard trainer about the end of 1917.

Before putting the 504K into production Canadian Aeroplanes Ltd. redesigned it to use some Canadian JN4 parts and also a new undercarriage was designed to simplify its production. This new landing gear may be seen in the illustration of the first Canadian 504 (Figure 19) and it provides the main distinguishing feature of the Canadian aircraft. A type letter was not given to the Canadian 504 aircraft which was fitted with a 130 hp Clerget engine supplied from England.

The original order was for 500 machines and the first aircraft was delivered on October 1, 1918, followed by the second (Figure 20) in early November. Due to cancellation of the order this was the last aircraft delivered to the RAF in Canada although parts had been manufactured for a hundred 504's by that time.

In the spring of 1918 some surplus manufacturing capacity was available at Canadian Aeroplanes Ltd. and a contract was secured for fifty F5L flying boats for the U.S. Navy (Figure 21).

The F5 was the last of a series of large twin engined flying boats developed by Commander Porte at Felixstowe and intended for long anti-submarine and reconnaissance patrols over the North Sea. Its appearance was too late to see any service use in the war but it was adopted by the U.S. Navy in whose service it was equipped with 400 hp Liberty engines and known as the F5L. This aircraft has also been ably described in Reference 14 and it may be noted that its span of 102 ft and gross weight of 12,900 lb made it the largest aircraft manufactured in Canada up to that time. In fact, there were to be no aircraft manufactured in Canada to surpass the F5L in size until almost twenty years later.

Production of the F5L commenced on April 22, 1918, and the first aircraft was completed on July 15 when it was shipped to the Philadelphia Navy Yard, where flight tests were carried out in August. In appearance, the airframe of the Canadian produced F5L's were the same as the British F5 boats when delivered, but it is believed that they were modified to carry a horn balanced rudder at a later date. Other American F5L's had a fin with a rounded leading edge together with a horn balanced rudder, but it is not known if any of the Canadian F5L's were so modified.

At the end of the war, the contract for fifty was reduced to thirty and when the last of these was delivered at the end of January, 1919, it was the last aircraft to be manufactured in Canada until 1923 when the aircraft department of Canadian Vickers was opened.

Figure 19
First Canadian Avro 504

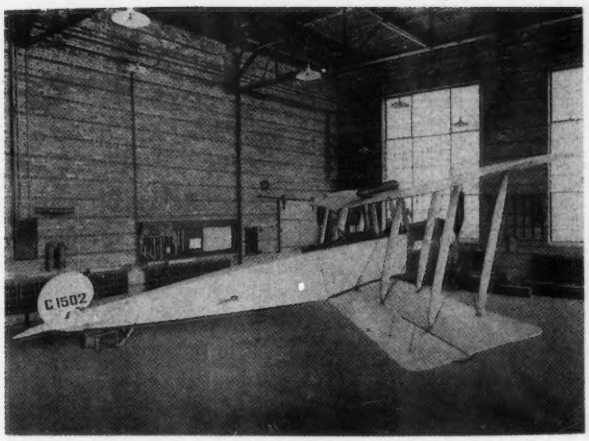

Figure 20
Second Canadian Avro 504

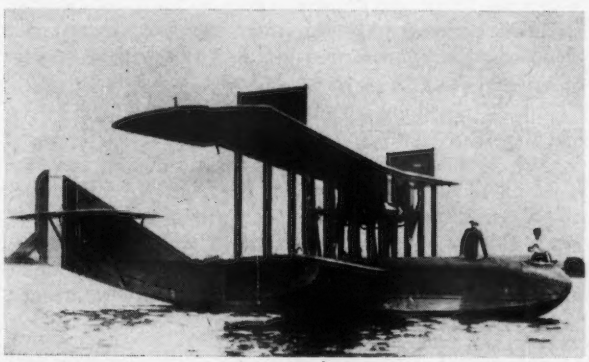

Figure 21
F5L built by Canadian Aeroplanes Ltd.

THOMAS F. HAMILTON

About the end of 1915, Thomas F. Hamilton, a young American aircraft designer, arrived in Vancouver where he obtained the use of a wood working factory on Fourth Ave. and commenced to construct an aircraft. He was assisted in this project by students of the Aero Club of British Columbia who, at that time, were without an aircraft.

Construction proceeded during the winter and spring of 1916 and it would appear that the aircraft was completed in the late spring or early summer. An illustration

showing a portion of the aircraft is shown in Reference 12, in which it can be seen as a three bay tractor biplane with wings of equal span.

The design of this aircraft is not established for although it has been described[12] as a "two seater military-type Curtiss" it would appear to have a Martin look about it. Murton A. Seymour, who helped construct it, states[15] "it certainly was not a Curtiss design but may have been, as you suggest, a Martin design, but this I do not know". It is also quite probable that the design was Mr. Hamilton's own because he later returned to the United States where he founded the Hamilton Metal Plane Co. and the Hamilton Standard Propeller Corp. Unfortunately no details of this aircraft are available.

HOFFAR BROTHERS

James and Henry Hoffar of Vancouver had their first introduction to aircraft in constructing a single float installation for Billy Stark's Curtiss pusher in 1915. Apparently this must have aroused their interest for they later constructed a two place tractor biplane powered with a 100 hp Roberts engine, also fitted with a single float. After it was completed in the summer of 1917, James Hoffar used it to teach himself to fly. No details of this aircraft have been recorded but an illustration of this aircraft may be seen in Reference 12. It is not believed to be of original design.

This seaplane was soon wrecked by striking a submerged log but, in spite of this, the two Hoffar brothers were soon busy constructing a flying boat powered with a Green engine. This aircraft was intended for forestry patrol and was purchased by the Provincial Government. However, the aircraft crashed owing to engine failure on its second flight and so was never used for its intended purpose. As with their previous aircraft, no details have been recorded but it is not believed to be of original design.

POLSON IRONWORKS CO.

While the activities of this Toronto company are not well recorded, it is known that two different types of two seat tractor biplanes were built in late 1915 or 1916. One of these is illustrated in Reference 16, unfortunately from dead astern, which makes it difficult to determine details, but it appears strongly influenced by the Curtiss JN design.

The other type was powered with a Sturtevant 140 hp engine. Again, little information is available but in Reference 17 it can be seen as a two bay biplane of equal span and of similar general appearance to contemporary American aircraft. It is believed to be of original design and incorporated a fuselage of steel tubing with wire bracing. It was tested at Hampstead Plain, N.Y., where it reportedly gave "good results".

Reference 18 states this latter aircraft to be "the first aeroplane built and designed entirely within Canada". This statement obviously does not take into account the work of the pioneers, such as the Pepper brothers and others[12].

AIRCRAFT ENGINE MANUFACTURE

While an aircraft engine had been produced in Canada prior to the first Great War, the first manufacture of aircraft engines on a production basis was undertaken by Willys-Overland Ltd. of Toronto.

The engine manufactured was the 200 hp Sunbeam Arab and it is stated[19] that "the company is credited by the British authorities with having contributed more to the development of the Sunbeam Arab engine than any other concern in the Empire". Unfortunately, no details of this programme are known to the author but 125 engines[20] were exported in 1918.

Finally, it may be said that considerable effort has been made within the time available to ensure that the information presented here is correct but in spite of this, errors may still be present. In many cases records are not complete and, in others, different sources disagree on the same point. However, where doubt exists it is hoped that the wording suitably reflects it. Should better or more complete information be available, the author would greatly appreciate being informed of it.

ACKNOWLEDGMENTS

I wish to gratefully acknowledge the assistance of M. A. Seymour who supplied the information on the Thomas F. Hamilton aircraft and the kindness of A. Petrie and Frank Baillie in loaning material on Canadian Aeroplanes Ltd. Also, the helpful comments and most appreciated loan of reference material from W. R. Richardson and C. J. Toms are gratefully acknowledged.

Finally, thanks are due to D. C. Rundle who kindly consented to act as editor and to my wife who typed many letters enquiring for information and photographs for this article as well as the original draft.

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CANADA AND THE AIRBORNE CAMERA

by W/C H. Pearce, RCAF Retd.

INTRODUCTION

Just who was the first to realize the tactical advantages of the viewpoint to be obtained from an airborne position is not important. Balloon observations were made during the American Civil War. In Britain the Royal Engineers had a very active "balloon company" at Farnborough before the 1914 war. They experimented extensively with "aerial" cameras for military purposes. These experiments were to pay great dividends in later years. It is a fact that photography from the air antedated the powered aircraft by several years. It is generally agreed that the first air photograph was taken by an enterprising photographer of San Francisco in the days immediately following the disastrous earthquake and fire of April, 1909, using a large wet plate camera attached to a captive balloon.

The air camera came into serious use in the First World War when each side strove to photograph the entrenchments of the other. It was not long after the close of this conflict that the crude wartime camera (Figure 1) was transferred intact to peacetime purposes. Prior to this, mapping had been conducted entirely from ground measurements, with photographs and sketches. This had one advantage in that the ground kept quite still while being measured, but the observer could not see very much from where he stood. From the air the map sketcher could see a great area but as his relative viewpoint was shifting rapidly he could not orient one feature relative to another with any accuracy. The camera by recording what it "saw" combined the advantages of both but it introduced other problems of its own. Amongst these was the very important problem of "where is down"; how, in other words, could the plumb point immediately below the aircraft be determined at any given moment? The axis of the camera lens then fixed rigidly to the aircraft "bobbed about" with the vehicle which supported it. This problem never has been solved outside the laboratory although many attempts have been made.

While he has never claimed credit for it, the Canadian surveyor has pioneered in many aspects of air survey; the very inaccessibility of the terrain of which he was expected to produce accurate maps intensified his adoption of the airborne vantage point from the earliest days of flying.

EARLY WORK IN CANADA

What is undoubtedly the first serious air photographic enterprise for mapping, in this country if not anywhere, concerns an expedition to Labrador led by Captain Daniel Owen in July, 1919. Owen, a veteran of the 1914-18 war in which he lost an eye and was taken prisoner of war, sailed from Annapolis, N.S., on July 7, 1919. He took with him 3 Curtiss JN4C aircraft and constructed a base some miles up to the Alexis River in Labrador after considerable personal risk. Within a few weeks Capt. Owen and his band of pioneers had photographed some 1,500,000 acres of Labrador timber in an area several miles east of the present Goose Bay airport.

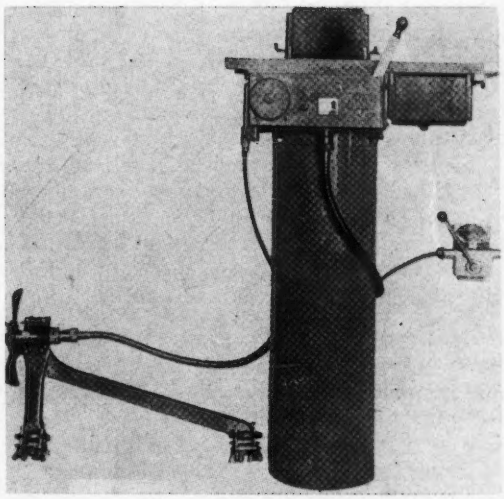


Figure 1
World War 1 aerial camera

Growing interest

By 1921, using cameras of 1918 war vintage, flying for survey photography was being systematically developed. In that year, for instance, the Government of Ontario having "expressed itself satisfied with the results obtained" contributed some $15,000 towards expenses in forestry survey photography in that province and "asked the Air Board to undertake operations on a larger scale next year". If finance be the criterion, then the Provincial surveyors in the Province of Quebec displayed real enthusiasm. At Roberval the Provincial Government "contributed a sum of $20,000 towards maintenance" and "spent a considerable amount on the erection of permanent buildings". In 1921 air photography appears to have been used for the first time in the peacetime solution of an international problem. A portion of the St. Croix River in New Brunswick was photographed for the International Boundary Commission in order to solve a dispute.

In the spring of 1922 the Dominion Government had decided to investigate methods of furthering exploration of our Arctic areas. In order to examine the practic-

ability of air exploration and survey, S/L R. A. Logan was sent on an expedition which included the northernmost portion of Baffin Island, Ellesmere Island and neighbouring areas. Ironically he did all his work from a surface ship. No aircraft were taken on the expedition. A report was submitted which said, "The problem is a large one and while it would be idle not to recognize the difficulties of operation, there is no doubt that aircraft can facilitate the exploration and mapping of the Arctic".

In 1923 there was great concern shown over the exploration and mapping potential of the aircraft but practically no interest in increased use of other kinds. A government report says, "During 1923 there has been no development of passenger, mail or express traffic in Canada". On the other hand, a Dominionwide conference of forestry engineers held in Ottawa in January, 1924, passed a resolution which in part read "resolved that the Canadian Society of Forestry Engineers recommend to the Dominion Government, having in view the value of aircraft in forest conservation work that steps be taken without delay, to design and construct types of aircraft suitable for such work in Canada . . ."

Aircraft and engines

During this formative period (1922-23), the photographic aircraft were mostly the HS2L Curtiss flying boat (Figure 2) and the DH4B landplane (Figure 3). These were part of a $5,000,000 gift of aircraft from the British Government in 1919. $5,000,000 purchased a lot of aircraft in those years.

Also during this period considerable emphasis was being placed on the lack of suitable powerplants. The

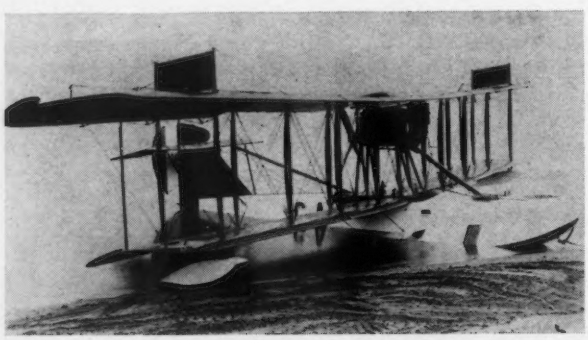


Figure 2
Curtiss HS2L

Figure 3
De Havilland DH4B

Figure 4
Canadian Oblique System

static radial engine had not yet made its appearance in a useful horsepower category and the rotary engine was still widely used. The chemical engineer had not yet produced ethylene glycol and the problems pertaining to the operation of the excellent Rolls-Royce Eagle and Wolseley Viper liquid-cooled engines during the Canadian winter were serious. Denatured alcohol and water was the only possible coolant and the low boiling point of this fluid at sea level even before gaining altitude meant operating the engine at low and inefficient temperature ranges.

Developing technique

By the year 1922 an interesting development in air survey methods took place that was to influence the construction of postwar aircraft. The mosaic and the resulting planimetric map was no longer meeting the needs of the surveyor. Dr. E. Deville, who was then Surveyor General, had been collaborating with Professor H. L. Cooke of Princeton University in evolving a method of producing contoured maps from overlapping photographs. A cartographic camera of new design was constructed. Professor Cooke conducted his original experiments with photographs of a courtyard taken successively from neighbouring windows of the laboratory. In 1922 some flying was conducted at Ottawa during September although it was noted that "the duration of exposure was ⅓ second" because "the light is not very strong in the latitude of Ottawa". It was also noted that the DH4B had to be considerably modified to accommodate cameras.

Now this collaboration between Dr. Deville and Professor Cooke is significant. Even at this early stage of the art (for it was not yet a science) it was evident that the equipment was inadequate for the demands which were to be made upon it. Dr. Deville started a programme of demanding scientific improvements to air cameras and related equipment which was to be continued by his successors through the years. This continued pressure by the surveyors was eventually to put Canada in the forefront of the field of aerial photogrammetry.

The era of the DH4B and HS2L saw cameras in use which had two features in common with that in the local

Figure 5
Huff Daland seaplane

portrait artist's emporium. Both used glass plate negatives and lenses of the same optical formula. What was ideal for the portrait was not so suitable for photogrammetry. It was, however, available. Optically the glass plate negative was ideal (and is used in specialized work today). It was heavy and bulky and of course easily broken. As we shall see, new and better equipment appeared.

In 1923 the Topographical Survey of Canada conducted experiments in the translation of oblique photographs into source material for maps. Previously, vertical photographs had been used almost exclusively. With the aircraft then available, this was costly in flying time, particularly where maps of first order accuracy were not required. The oblique, which looked out to and included the horizon, covered a greater area; it was limited only by the decreasing scale in the distance. And thus was derived the Canadian Oblique System (Figure 4) which over the years evolved into the tri-camera aeronautical charting method, which was to be employed so successfully in completing the basic aeronautical charts of Canada.

1924: NEW AIRCRAFT

In the field of commercial survey operations, we find a few companies active by the end of 1923. Laurentide Air Services, Fairchild Aerial Surveys Company (of Canada) Ltd., the Dominion Aerial Exploration Company and the Ontario Pulp and Paper Co. were well established. The aircraft of those days bore names no longer familiar with the possible exception of De Havilland. There was the HS2L flying boat, the Schreck flying boat, and the Huff Daland seaplane (Figure 5) among others.

Vickers Viking

By 1924 the operational shortcomings and old age of the 1918 aircraft had finally made necessary the production of new ones to replace them. During 1923 a contract had been let to Vickers for the production of 8 single-engined amphibians. They were to have been produced in Canada but due to delays in establishing factory facilities in Montreal the first 2 were produced in the parent factory in England. The remaining 6 were built at Vickers' new Montreal factory. This aircraft was the Viking (Figure 6) and followed conventional marine structural methods. The hull was of laminated mahogany strip. The Viking did a lot of good work on photographic oblique surveys and forestry patrols. At its all up weight of just over 5,500 lb, it had a relatively low ceiling of just over 5,000 ft and a duration of under 4 hrs.

Vickers Vedette

Out of the need for new aircraft came the first product to be both designed and produced in quantity in Canada to a Canadian operational specification. This was the very efficient Vickers Vedette (Figure 7) designed by W. J. Reid of Canadian Vickers. So successful was the Vedette that although designed in 1924 several were still in use at the seaplane school at Trenton at the outbreak of war in 1939. This aircraft, although designed for the RCAF, was adopted by the Ontario Provincial Air Service and some commercial operators.

Some paragraphs back I recounted that the lack of suitable powerplants had handicapped design. The Rolls-Royce and Wolseley engines were very reliable but the lack of a suitable anti-freeze handicapped their use in the Canadian winter. The air-cooled rotary radial engine was old, tired and becoming by age thoroughly unreliable. At the time of the Vedette design it had been intended to use the Rolls-Royce Falcon. The prototype first flew with the liquid-cooled engine. There then be-

Figure 6
Vickers Viking

Figure 7
Vickers Vedette

Figure 8
Fokker C11

came available the first of a series of very successful static radial engines, the Armstrong Siddeley Lynx. The Lynx-engined Vedette was eventually to do initial surveys of the Victoria and Banks Islands in the Arctic, a truly remarkable effort when judged by today's standards of flight safety.

Fokker C11

The year 1925 saw air photography and contoured surveys first used for projecting the construction of new railway lines. A section of the Canadian National near Rouyn in Quebec was photographed and plotted by Brock and Weymouth of Montreal – a subsidiary of the Philadelphia Company of the same name. Of particular interest was the aircraft employed, a Fokker C11 (Figure 8). In appearance it was a considerably enlarged duplicate of the famous German Fokker DV11 fighter of the 1918 period. It had a canopied cockpit however. It is again interesting to note how the short range of aircraft handicapped more extensive use of air survey in the mid-twenties. The Chief Engineer, Construction Department CNR, while enthusiastic over the results obtained, reported "the cost of getting the aeroplane on the ground appears to limit the use . . ." The aeroplane had been taken in by rail over the completed portion of the CNR.

Vickers Velos

Although but an infinitesimal part of Canada's several million square miles had been surveyed from the air by 1926, the results which had been obtained so whetted the surveyor's appetite for more that the question of a special photographic aircraft was considered. The Vedette had accomplished so much as a small general purpose flying boat that specialization might pay even more dividends.

A specification for a photographic aircraft was drawn up based on the best information then available on survey requirements. The Vickers Velos, a twin-engined float plane with pusher propellers aft of the wings resulted. That it was not successful is no reflection on its constructors. It proved once and for all time that it was economically unsound to construct an aircraft so specialized that it could be used for nothing but photography – and not for that if requirements changed to a significant degree, as was shortly to be the case. Others have tried to do the same but the project has always been dropped sooner or later for reasons of economics. From then on, survey and exploration were to be carried out by the proven general purpose Vedette and increasingly by new cabin monoplanes on floats. New and reliable air-cooled engines of economical performance marked the appearance of the "bush" aircraft. Canada's frontiers started to move northward.

OPERATIONAL DIFFICULTIES IN THE '20'S

It is now necessary to emphasize that photographs are not just pasted together to form a map. The establishment of ground control, by propagation of triangulation from known points or by the establishment of astronomic control points is a long laborious business. Not for some three decades was the extension of control by electronic means to become practical. Aside from the crew in the air, the surveyor on the ground had to be moved. It is difficult for anyone whose flying experience is entirely modern with multi-engined aircraft moving at several hundred miles per hour from Montreal, Ottawa or Winnipeg to Baffin Island or to Southampton or maybe Thule to realize the difficulties encountered in early operations. Fuel and living supplies had frequently to be moved by tractor train and sled the winter before and cached on lake shores or barged down rivers to other sites. The gas cache was a famous northern institution. Pilots provided with cache site books would refuel and report their consumption "outside" on return. The state of the cache could thus be accurately estimated and supplies replenished during the next transport season. Interference with caches was a serious offence and such was the respect for supplies so located that theft was almost unknown.

Up to 1927 practically all work had been carried out in open cockpit aircraft of relatively low performance characteristics. Work was of a necessity restricted to the summer months and, with the possible exception of DH4B flying out of the High River, Alta. area, only flying boats had generally been used. There were very few suitable landing areas aside from water, of which there was plenty. The possibility of a systematic mass coverage of Canada for basic mapping was out of the question. Areas were photographed for the surveyor in accordance with economic demands. The pulp and paper companies had been quick to realize the ad-

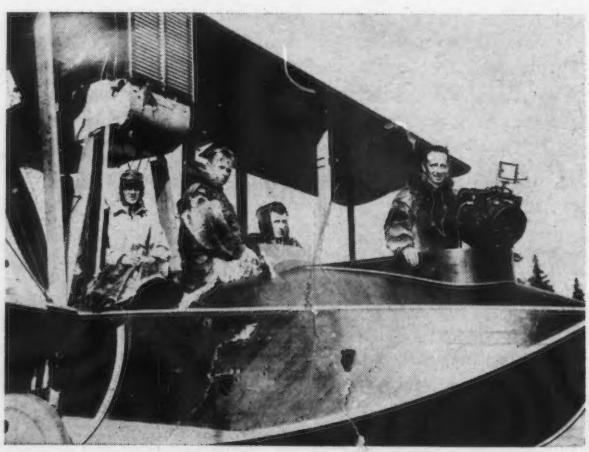


Figure 9
Camera mounting on the Viking

Figure 10
A fan of low altitude mapping obliques taken by one camera

vantages of photography for forest inventory purposes. Such coverage occupied almost the entire efforts of the commercial survey companies. The RCAF producing coverage for Government departments placed its efforts on areas of prime importance. The spruce bud worm had infested a forest area in northern Ontario. Irrigation of some prairie areas was under study so that accurate coverage of lake and river areas was necessary.

I have not, so far, said much about the technical aspects of photography. It was to be many years before any great technical advance occurred. Hours of flying were restricted to the two or three hours each side of local meridian because of the slowness of emulsions. The lenses available were not at all comparable with today's optics. Photographic processing was not as carefully controlled as was subsequently to be the case, and research was casual. It was to take the war in 1939 and the subsequent intense reconnaissance effort to alter this.

Navigation for photographic lines was for many years very largely a matter of personal skill and intuition. Some pilots flew lines that when plotted were quite straight and consecutive. Others never quite caught on. To be fair, one must admit the paucity of instruments and their inaccuracy. Two altimeters on the same aircraft might show a differential of 400 ft despite having been zeroed at takeoff but an hour before.

THE PASSING OF THE FLYING BOAT

In 1927 the advent of the cabin monoplane introduced an era of relative comfort for the crew and improved camera installations. In the older boats, the lifting of a thirty to forty pound camera from its stowage, mounting it on an exposed trunnion (Figure 9) and thereafter swinging it from side to side against even a gentle slipstream of 60-odd mph was not exactly a casual task. However, the oblique coverage (Figure 10) thus obtained, so profitably, in the Viking and Vedette was still a necessary requirement of the faster and more comfortable cabin aircraft.

The Bellanca Pacemaker

The configuration of the Bellanca Pacemaker lent itself to the first tri-camera mount (Figures 11 and 12). These three cameras working together had several advantages. Longer flight lines were possible and the photographs could be interconnected with greater accuracy from this relatively rigid mount than was the case with the single camera bobbing about from side to side on its track and trunnion. The extreme wide angle

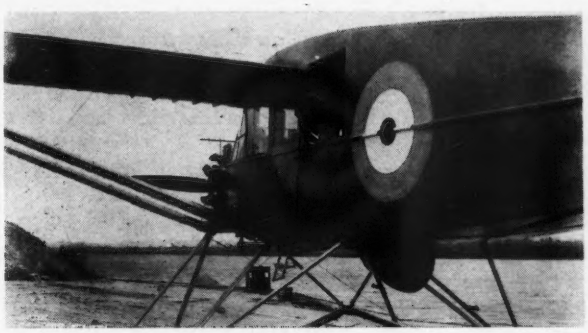


Figure 11
Port and ventral cameras: Bellanca Pacemaker

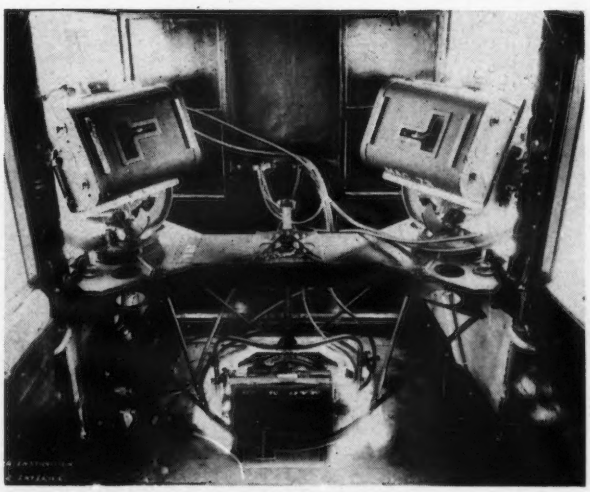


Figure 12
Camera installation: Bellanca Pacemaker

lens with its view of 90° had not yet appeared, to bring joy to the heart of the photogrammetrist and headaches to the aircraft designer. As it was, bits of float and other visual obstructions appeared in each exposure.

Hudson Bay Expedition 1927

At this point it is appropriate to make a brief reference to the Hudson Bay Expedition of 1927-28, which was undertaken to investigate the feasibility of grain ship navigation from Churchill to Europe via Hudson Bay and the Straits. The expedition was taken in and out by sea. Two Fokker Universal cabin mono-

Figure 13
Fokker Universal

planes (Figure 13), equipped with float, ski and wheel landing gear, operated from each of three bases, and in November and December, 1927, carried out 26 meteorological and ice observation flights. The success of the expedition was largely due to the excellent characteristics of these aircraft.

CENTRAL LIBRARY 1927

The air photographic programme, started so experimentally after the 1914-18 war, had, by the mid '20's, shown that the coverage obtained could be used for a multitude of purposes. The same photograph might be used under widely different circumstances and by authorities not necessarily having any great administrative relationship. While this may not appear to have a great deal to do with the evolution of survey aircraft, yet the establishment of a central library for all Dominion Government air photographs has had a most beneficial effect. Under Order in Council P.C. 180, the Topographical Survey, Department of the Interior (now Mines and Technical Surveys) was made the custodian for all coverage regardless of the identity of the originating authority. By preventing duplication of effort, the relatively small resources at our disposal were wisely employed, and orderly growth resulted. That the Canadian air survey programme in all its years has not been the subject of public criticism for waste has been largely due to the foresight which brought this library and control into being and the efficient way in which it has been operated throughout its history.

THE '30'S

With the advent of the early thirties, the full impact of the economic depression brought a halt to air survey technical development – and almost a stop to exploration of the country. And so for some 5 years only a very few square miles per annum were added to the inventory of the country. By 1936 a man by the name of Schickelgruber made military air operations in Canada – as in other countries – a good idea. There was once again a demand for increased mapping coverage, particularly of areas of strategic importance and of critical natural resources.

Northrop Delta

Aside from operational squadron aircraft, there appeared for the first time what was then a relatively high performance survey aircraft. This was the Northrop Delta (Figures 14, 15 and 16) which went out on survey detachment work in the spring of 1937. Because it was

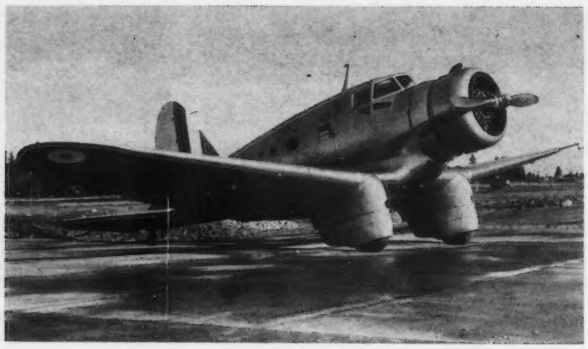


Figure 14
Northrop Delta

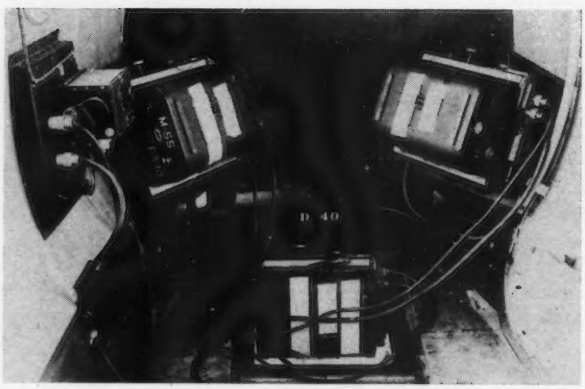


Figure 15
Camera installation: Northrop Delta

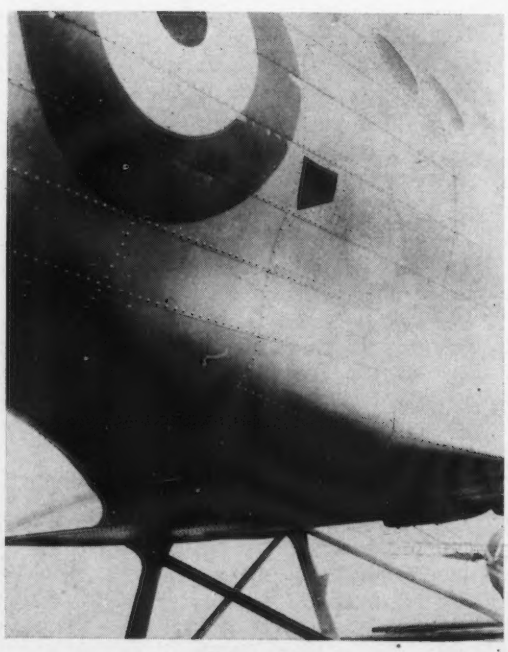


Figure 16
Starboard and ventral camera ports: Northrop Delta (on floats)

the first low wing monoplane to appear in the RCAF, it was greeted with some suspicion and many frightening tales were passed around about unknown characteristics. In good hands, it opened up a new concept of square mileage per flying hour and in doing so made the development of new high speed mapping methods essential. It might be well to stress here that the surveyors in Canada could never be stampeded into accomplishment of great areas at high speed if such accomplishment was achieved at the price of inaccuracy. This policy was a wise one as events were to prove. The Delta had a short survey life. The outbreak of war in 1939 saw every conceivable aircraft thrown into coastal and antisubmarine patrols, and the gradual evolution of the survey aircraft came to a sudden halt. Although the war years, from 1939 to 1945, resulted in no domestic air survey, research in photographic reconnaissance problems was in postwar years to pay big dividends.

WARTIME DEVELOPMENTS

Early in 1939 General von Fritsch, the German Chief of Staff, said, "The side with the best photographic reconnaissance will win the next war". Apparently no one paid too much attention to him – at least on his own side. The admitted German efficiency in photographic technique was not in evidence. Despite a strong temptation to do so, I must avoid going too far into wartime photographic reconnaissance. This is a story of absorbing interest in itself. I must, however, mention a few items which arose out of wartime research because these items were directly applied to postwar air survey in Canada. I will divide them conveniently into broad headings.

Altitude

Peacetime air surveys, prior to 1939, were for the most part carried out at altitudes of from 3,000 to 10,000 ft. Aircraft performance made greater altitudes not too practical and the state of photographic technique, both optics and chemistry, was not compatible with greater height. The resolving power of the camera/film combination was such that essential detail just could not be reproduced under operational conditions. Figure 17 is a typical example of the best that could be done with prewar techniques.

With the fall of France, photographic reconnaissance was called upon to provide no less than 87% of our intelligence. Photography from 3,000 ft or from 5,000 or 10,000 ft was sheer suicide. Yet we needed the image detail, and the tactical situation was such that only an unarmed small aircraft flying at great altitude could survive. We had to have more and better detail, from 30,000 ft and at high speeds, than peacetime surveys had heretofore accepted as optimum at casual altitudes and leisurely speeds. There was to be no single answer; Winston Churchill's blood, sweat, toil, and tears was literally applicable to the research programme. (A pilot model of a carefully calculated and critically produced telephoto lens was produced in the Optics Division of the National Research Council in Ottawa, was handled by air courier to London, installed in a waiting camera and had been used on a Berlin reconnaissance within 48 hrs of dispatch.) The need for improved optics

Figure 17
Typical of prewar photographic techniques: compare with Figure 29

forced a programme of Einsteinian complexity to which the National Research Council contributed much.

Aircraft

The use of the Spitfire aircraft (Figure 18) as a reconnaissance vehicle required the solution of two major problems – the effects on photographic resolution of extreme cold at altitude and the need to insulate the camera from engine and airframe vibration. Both factors contributed a significant amount of deterioration to the photographic image. To retain the camera in a heated compartment put the lens behind a glass window for the first time. This set in motion investigation into optical flat qualities. Keeping the camera warm was relatively easy. It was confined in the same compartment as the pilot. He was given a manually operated heat control. If he kept himself warm, he also met the needs of science. Another significant factor was the retractable undercarriage. Now for the first time a downward or outward to horizon view became possible without bits of aeroplane being included. Anyone whose total flying experience only includes retractable undercarriage aircraft can scarcely appreciate the multitude of problems solved by this one factor.

Lenses

The period of 1939-45 saw a phenomenal rise in the production of optical glass of unique qualities. Lenses of extreme wide angle now became a matter of routine

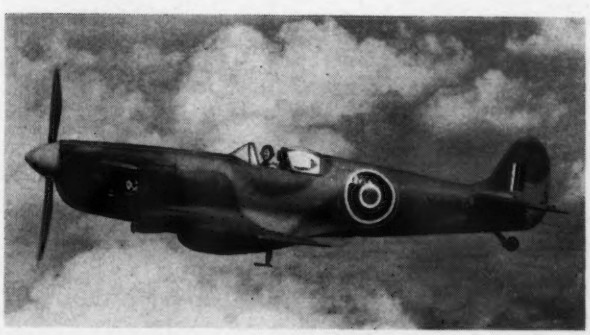


Figure 18
Spitfire PRV

production. So did the telephoto equipment. Optics for range finders and like equipment on warships reached a degree of development beyond expectations of but a year or two prior to 1939. And then was almost entirely swept away by radar developments.

Film

Film speeds, under increased war pressure, were raised to an unheard of degree. The most important factor was the achievement of stability at the same time. This meant that the use of higher shutter speeds became possible. These higher speeds in turn somewhat decreased the problems of motion and vibration.

World mapping and reconnaissance

In the division of tactical and strategical responsibilities the Royal Air Force with the Spitfire and Mosquito literally saturated continental Europe with photographic reconnaissance. Many P.R. pilots were Canadian and Canada contributed very much to research. The United States, faced with the enormous problem of island hopping its way back across the Pacific Ocean and land masses, found that it had few maps of the enemy-held territory. Out of this was evolved the tri-metrogon method of high speed aeronautic chart compilation. This was in reality an evolution of the early Canadian oblique type of photography. It was named for the Metrogon lens with which the camera was fitted. The USAAF put into action mapping squadrons of Flying Fortresses and Mitchell bombers converted into long range photographic aircraft. They paralleled these field operations with the development of an almost entirely mechanical method of converting photographs into maps at 1:1,000,000 scale at a rate of thousands of square miles per day. This was the most significant single mapping development to come out of the war. It was to have a far reaching effect on the postwar aeronautic charting and small scale mapping programme in the Canadian north.

POSTWAR DEVELOPMENT

At the end of the war, in 1945, the Canadian Government made several decisions which brought air sur-

Figure 19
Buffalo census

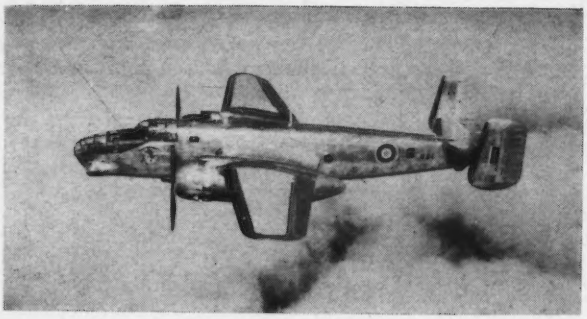


Figure 20
North American Mitchell

Figure 21
Douglas Dakota

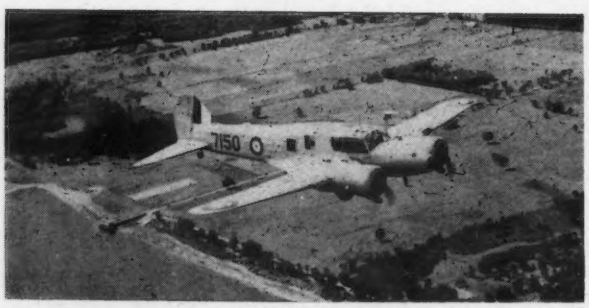
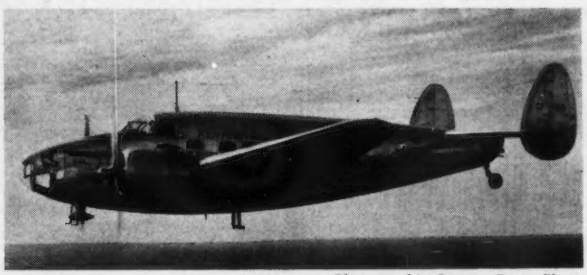


Figure 22
Avro Anson

Figure 23
Avro Lancaster

Photographic Survey Corp. Photo

Figure 24
Photographic Survey's Fortress



Photographic Survey Corp. Photo

Figure 25
Photographic Survey's Ventura

Spartan Air Services Photo

Figure 26
Spartan Air Services' Mosquito

Spartan Air Services Photo

Figure 27
Spartan Air Services' Cessna 310

vey operations once more into a prominent position. The war had shown the need for more accurate maps – only some 5% of Canada had been covered with first order accuracy. It was evident to the Government that Canada would occupy a more prominent place in world affairs and that our strength would come first of all from our natural resources. However, despite our pre-

Figure 28
Integral mounting of three cameras

war efforts, we had but a poor idea of what we really owned; no shopkeeper ever possessed such an incomplete inventory. The answer was to come from a vast programme of natural resources surveys; even the counting of buffalo herds (Figure 19). We had aircraft, such as the Mitchell (Figure 20), the Dakota (Figure 21), the Anson (Figure 22), and the Lancaster (Figure 23), which could be readily modified for air photographic purposes. We had a large number of aircrew who were anxious to continue flying but who had to learn a new and peaceful application for their skills. We had a whole new approach to the photographic problem – it could now be treated as a science. We had new laboratory equipment readily convertible to peacetime needs. But above all we had a lot of wise counsel – surveyors and foresters, agricultural specialists and geologists. All of these had been waiting overly long for just such an opportunity. If we were to take inventory and map, then let it be done with accuracy.

With the advent of such a vast programme there arose opportunities for commercial operators in the air photographic and survey fields. Personnel trained in RCAF operations or laboratories returned to civil life after gaining experience and found opportunities with newly formed enterprises. This commercial expansion into a field almost entirely carried out by the RCAF over many years was a very wise move. It introduced a programmed flexibility that could meet the urgent needs of new natural resources industries. It provided many young Canadians with an incentive they needed, particularly at that time. Typical aircraft used by these commercial operators are shown in Figures 24 to 27.

Cameras

The high speed aeronautical charting system evolved by the USAAF for worldwide war coverage was subject to some very drastic technical alterations. Two major problems had to be solved immediately. First of all, the three cameras, which had heretofore been mounted loosely together, had to be so individually improved and locked together that they became effectively an integral unit (Figure 28). The tolerance set by the Chief Topographical Engineer was 0.5 minutes of arc between any pair of axes or planes. This was a rigid specification

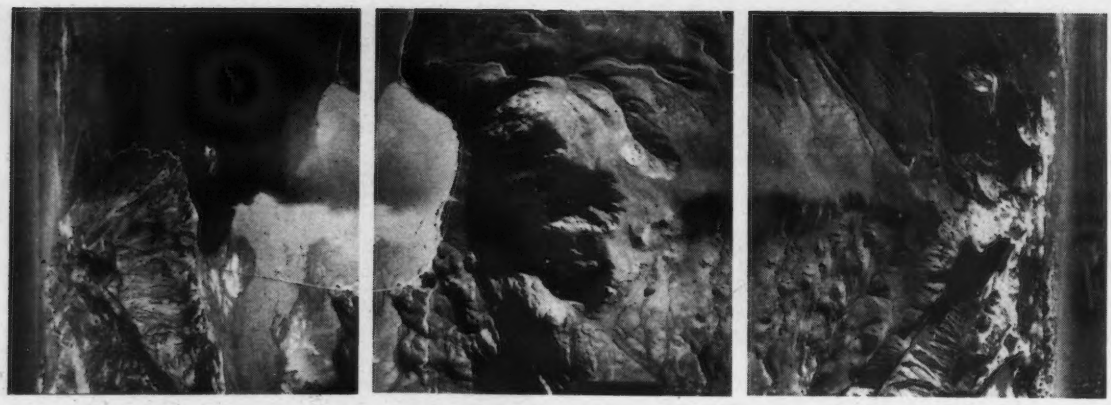


Figure 29
Tri-camera simultaneous photographs from horizon to horizon

which was achieved by the combined efforts of the National Research Council and the RCAF. To install the resultant mount meant a redesign of the nose of the B-25 aircraft. These interlocking cameras produced superb results; Figure 29 is an example.

Navigation

The second problem involved playing checkers with groups of surveyors, who were to be moved from place to place establishing astronomic control points which would provide the skeleton upon which the mapping would proceed. Available aircraft made this possible. And now the problem of flying straight lines over unmapped territory alone remained.

Parallel lines were achieved by the use of a unique instrument, the Fairchild Eliel Solar Navigator. In reality this was a gyro stabilized, constant reading sextant. Into it was fed by dial the latitude and longitude, the date and time, the desired course and drift. The information was fed to the pilot by means of an "on course" needle. One half degree error in course was positively indicated. In fact this instrument, rebuilt aircraft, redesigned cameras and mounts, and skilled aircrew were to make source material previously useful only at 1:1,000,000 charting now excellent for 1:250,000 planimetric mapping. A fourfold profit achieved by intelligent cooperation.

Shoran

Within 5 years of the end of the war, air survey underwent another revolution. For 30 and more years the loose term "air survey" meant only one thing – the use of air photography for mapping and natural resources assessment purposes. All interpretation was visual. Mapping control was optical, being carried out by triangulation networks extended slowly across country or by astronomic observation at remote points. A wartime electronic bombing control system had been undergoing refinements. If it was possible to position an aircraft over enemy territory with such accuracy that destruction of selected targets could be certain, might this system, refined to a considerable degree, not position a survey aircraft over unmapped territory with the accuracy required for mapping? It could, and a new name, Shoran, appeared in the language of the surveyor. Lancaster aircraft of the RCAF survey squadrons were employed in the early experiments in the Canadian Arctic. The measurement of electronic pulses replaced visual observation by optical means and new accuracy was achieved. Shoran, for the propagation of survey control, is accepted almost casually in this Golden Anniversary of Flight year; ten years previously it was still in the experimental stage.

Magnetometer

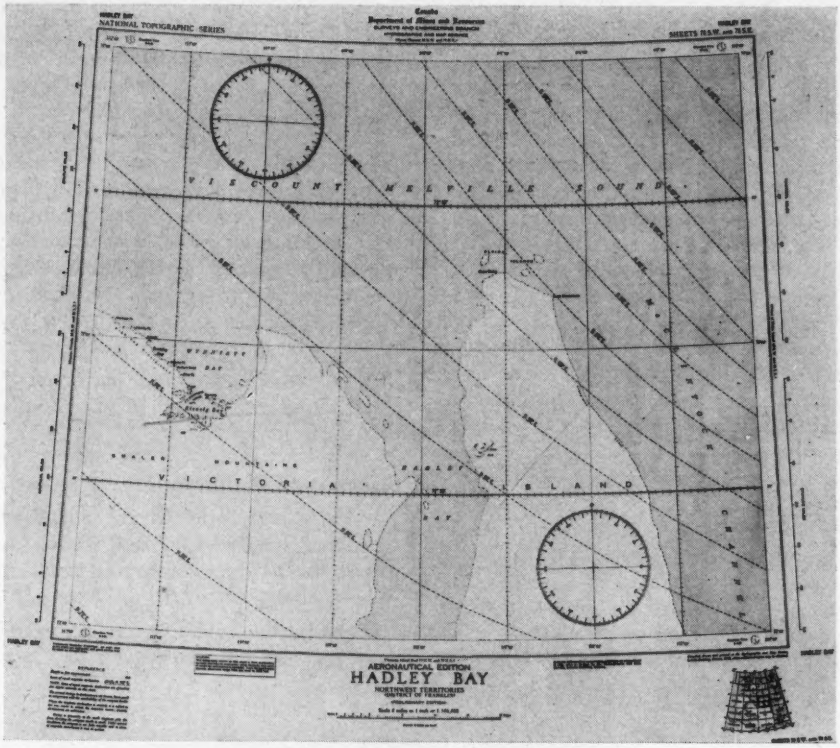
Other new instruments appeared which were to have a profound effect on the assessment of our mineral and oil resources surveys. The broad generic term airborne magnetometer could be applied. These instruments, measuring minute changes in local magnetic fields, provided a new tool for the geologist. The visual appearance of the earth's surface, as depicted in the photo with electronic information provided by the airborne instrument, gave a new impetus to geological discovery. It is quite reasonable to claim that several major Canadian resources developments have been made possible only by reason of the airborne "black box".

Radio altimeter

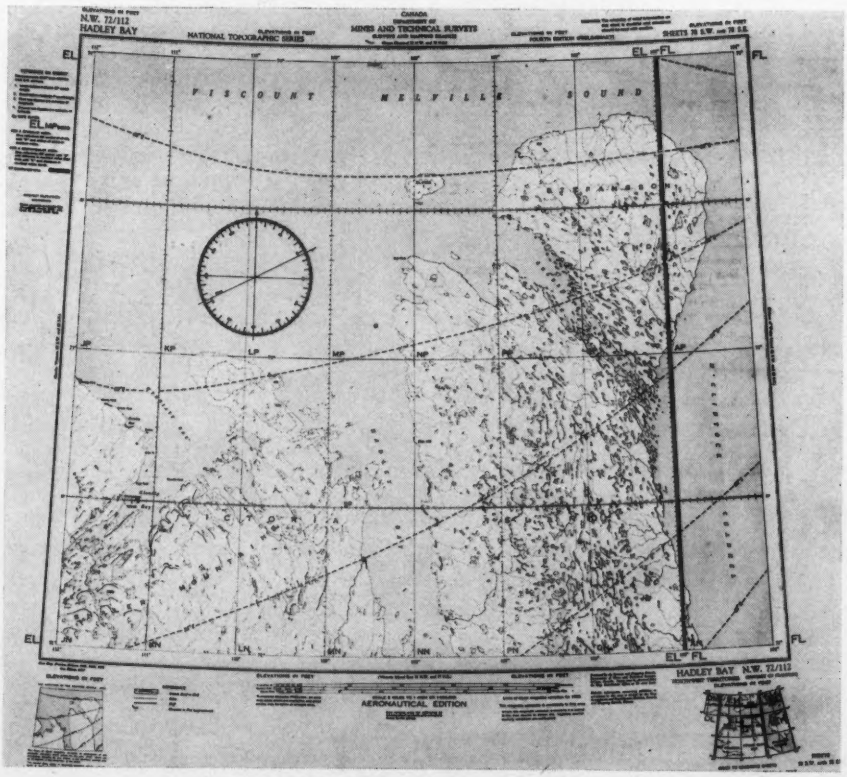
The radio altimeter also plays a large part. Modified, it traces profile of the surface of the earth over which it is airborne. As its angle of scan was made narrower, so its accurary increased and now "profile recorders" provide the photogrammetrist with additional information for the solution of map contouring problems.

Tellurometer

While it is not an airborne recording instrument, yet another has appeared which will have a profound effect on survey operations. This is the Tellurometer, an instrument developed in South Africa and adapted for Canadian use by the National Research Council. This is a distance measuring device, air transportable, which can "see" the distance between features under atmospheric conditions which preclude visual theodolite observation, and over greater distances. Certainly distance measurement with accuracy is going to be greatly accelerated with this and related instruments. Like all other equipment, however, the ultimate value will lie in the air transportability of the "black boxes".



(a) Map of Hadley Bay — 1943



(b) Map of Hadley Bay — 1957

Figure 30

Results

The results of the postwar work in Canada are impressive. The area of large scale mapping (scale 1:50,000) has increased from 5%, at the end of the war, to some 23%, at the present time. Aeronautical charts and associated maps (scale 1:1,000,000) which were restricted to a few strip maps of air routes before the war are now in publication for all of Canada, including the Arctic Islands – all of this from air photography. There is an interesting comparison between Figures 30 (a) and (b) showing maps of the same area in 1943 and 1957.

THE FUTURE

What of the future? The exploration and resources inventory of Canada must be kept up to date. The entire face of eastern Canada will change rapidly as a result of the St. Lawrence Seaway – itself made possible after exhaustive aerial photogrammetry. The ore developments of northern Quebec have made large scale mapping important in that area. There will continue to be a need for frequent surveys of oil field areas, forests and, in fact, of the entire surface of our country. Despite this, I see no necessity for developing a specialized photographic aircraft. The advent of the jet and turboprop makes some careful planning necessary. The smoothness of turbine power offers many advantages for photography and instrumentation, but the high cruising speed poses problems. Adaptations of smaller executive type aircraft will, I think, continue to be the most practical answer to the problem (Figure 27). There is no longer any necessity for very large air cameras. I am afraid they have just become a habit. Optical developments of the past 10 years make a camera using 70 mm film the logical development. I will go so far as to suggest that the operator who first brings such equipment to perfection will be able to reduce his aircraft overhead to such an extent that he could widen his opportunities to an unexpected degree.

We have come a long way since Capt. Owen took his expedition to Labrador. Canada has grown into one of the world's foremost industrial countries. The aircraft, used for survey, exploration and transportation, has made it possible.

ACKNOWLEDGMENT

My grateful thanks are due to the RCAF Photographic Establishment, Rockcliffe, for their courtesy in supplying all the photographs used in this article, except where otherwise noted.

Quotations, where given, are extracted from *Reports on Civil Aviation, Dominion of Canada, 1921-29.*

McCURDY AWARD

The McCurdy Award will be presented at the Annual General Meeting which will be held on the 15th-17th June, 1959.

It is presented each year

To A Resident of Canada,

For Achievement in design, manufacture or maintenance related to aeronautics.

NOMINATIONS ARE INVITED

Each nomination should include

(a) The name and affiliation of the nominee,

(b) Confirmation that he is a resident of Canada,

(c) A citation of the particular achievement for which the nomination is being put forward, and

(d) The name of the nominator.

The nominee need not be a member of the C.A.I. and the achievement need not have taken place within the last year, though it should be recent.

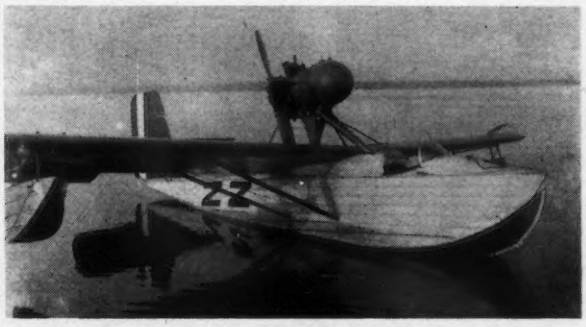
Nominations should be in the hands of the Secretary not later than the 14th March, on which date they will be handed over to the McCurdy Award Selection Committee.

AN ASSORTMENT OF OLD FRIENDS

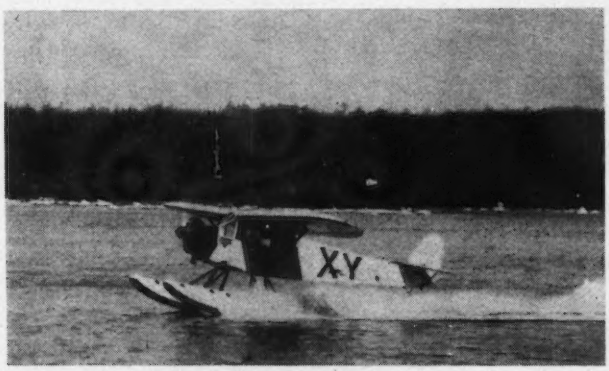
THE pictures on this and the following pages are not intended to indicate any historical trend or to have any other profound significance. They are just pictures of aircraft that have at one time or another worked in Canada. Some were important in the evolution of Canadian aviation, and others came and went, leaving few achievements behind them. All of them, regardless of their fame, represent the thinking, the work and the enterprise of the men who made them and used them.

If these pictures serve to evoke a few fond memories and tall tales, well and good.

We are indebted to the RCAF Photographic Establishment, Rockcliffe, for these photographs.



Canadian Vickers Vista: Siddeley Genet engine



Fairchild "Razorback": Wright JC5A engine

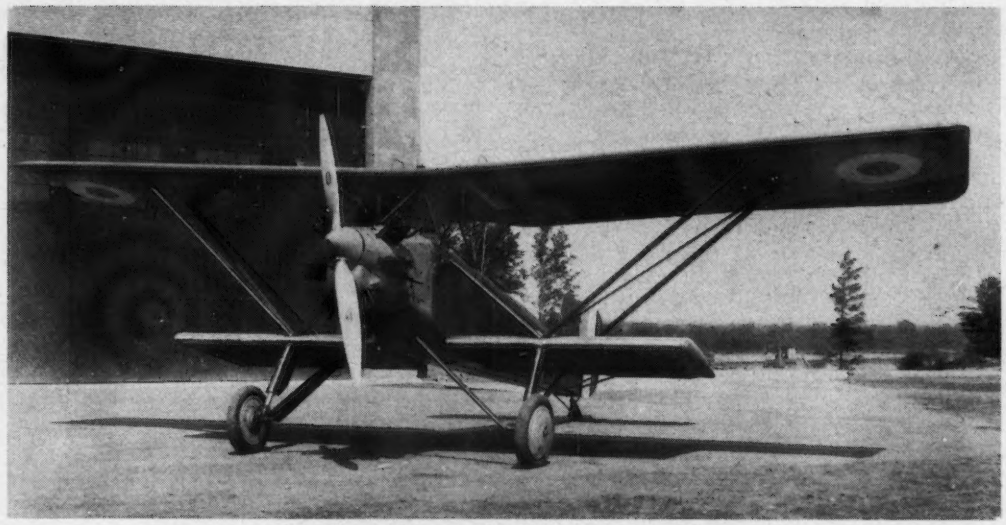
Ford Tri-motor: Wright J6 engines

Consolidated Courier: Wright J5 engine

Douglas Cruiser: Pratt & Whitney Wasp engine

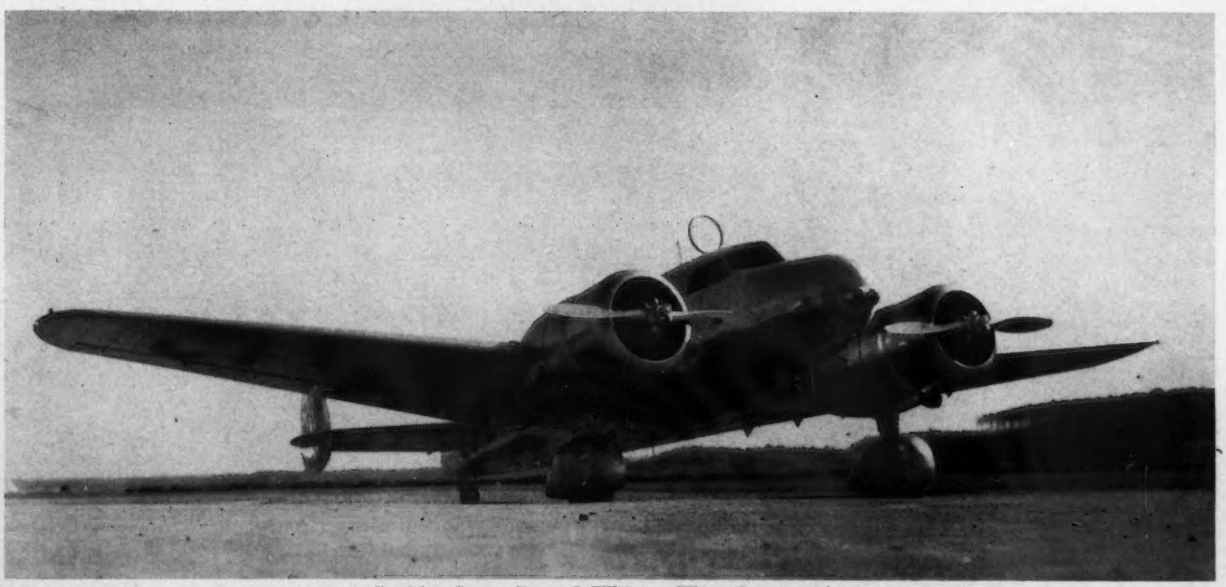
Armstrong-Whitworth Siskin: Siddeley Jaguar engine

Armstrong-Whitworth Atlas:
Siddeley Jaguar engine

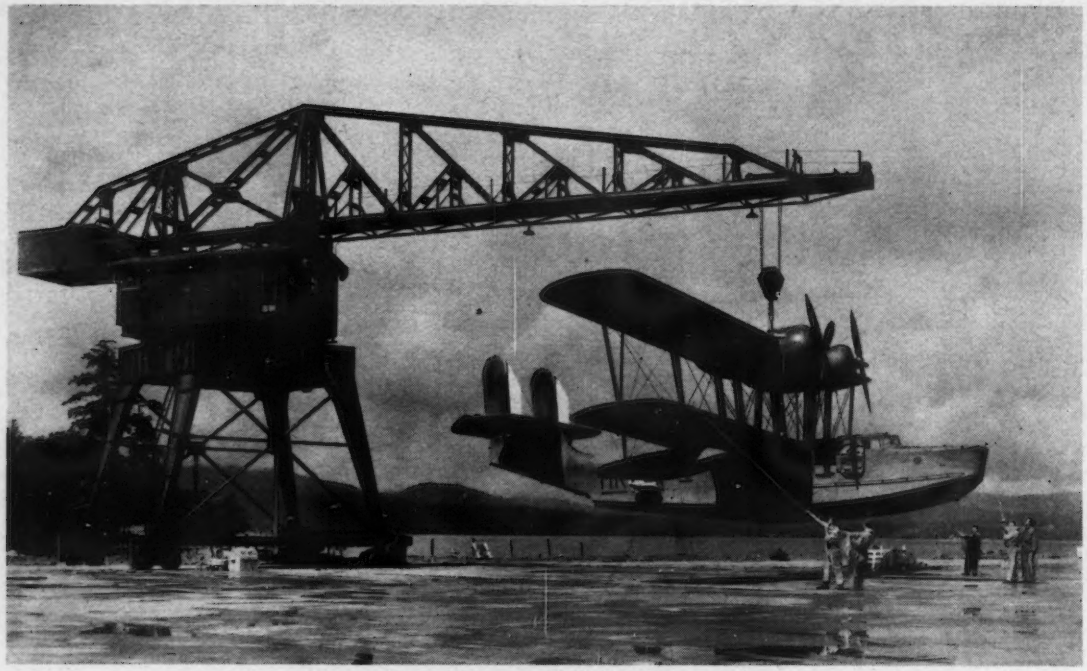


Canadian Vickers Vigil: Siddeley Lynx engine

Curtiss-Reid Rambler: ADC Cirrus Hermes engine

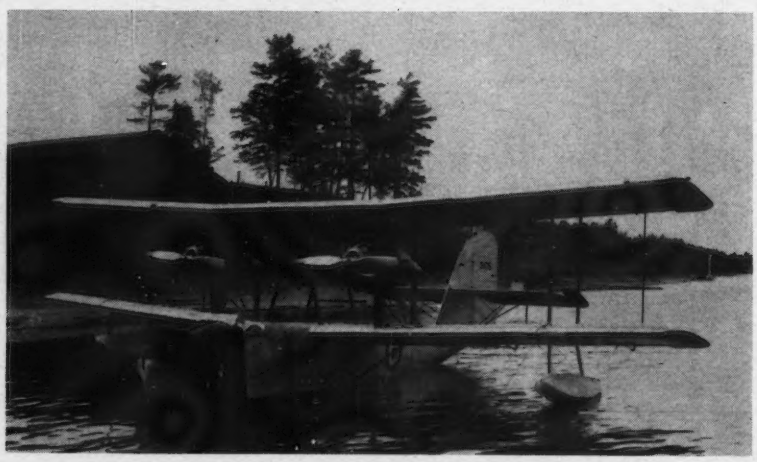


Barkley-Grow: Pratt & Whitney Wasp Jnr engines

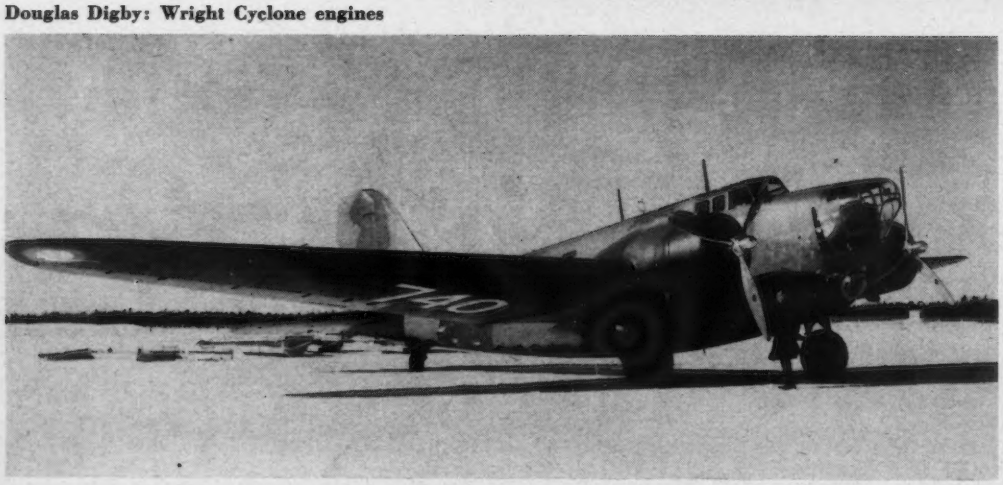


Supermarine Stranraer: Bristol Pegasus engines

Canadian Vickers Vancouver: Wright J6 engine

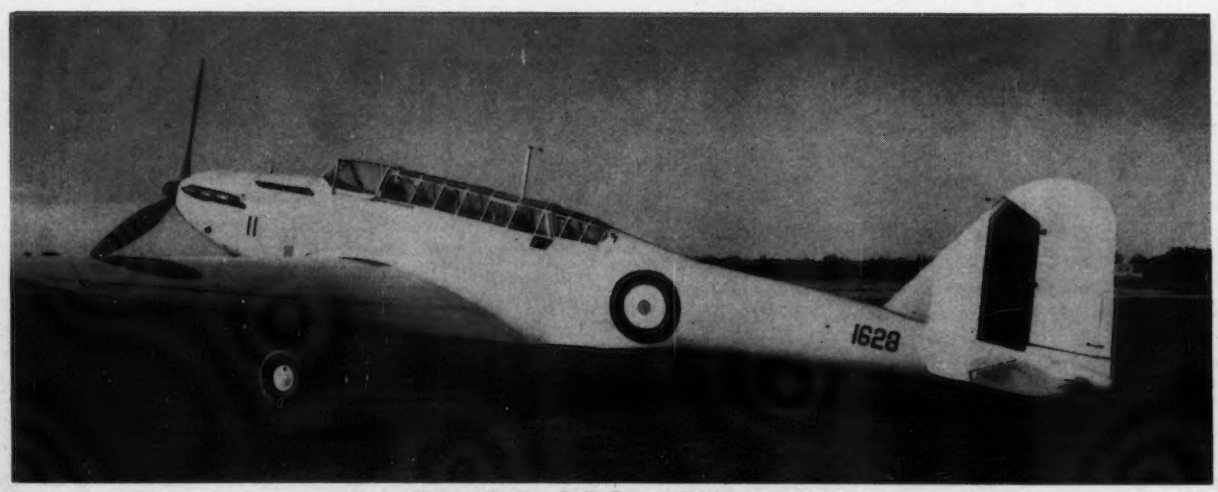


Douglas Digby: Wright Cyclone engines



Blackburn (Boeing of Canada) Shark: Bristol Pegasus engine

Airspeed Oxford:
Siddeley Cheetah engines



Fairey Battle: Rolls-Royce Merlin engine

C.A.I. LOG

SECRETARY'S LETTER

SPECIAL ANNIVERSARY MEETING

By the time this issue of the Journal is in your hands, the Special Anniversary Meeting, to be held on the 23rd and 24th February, will be almost upon us. But it is not too late to enlarge a little on the information already published about it; the Notice that has been distributed could tell only half the story.

The Dinner

Firstly, about the Dinner. It was never intended that the National Coordinating Council for the Golden Anniversary of Flight in Canada should initiate anything; its job has been to coordinate the programmes of its member organizations. When the Council was formed, the Institute had already taken the first steps in the planning of this Dinner on the 23rd February and we agreed to broaden the scope of our celebration, to develop it into something of a national event in which the other member organizations could participate.

Accordingly our Head Table will comprise the senior representatives of these organizations, including, we hope, the Ministers of Defence and Transport, the Chiefs of Staff of the three Services, the President of the National Research Council, the Chairman of the Defence Research Board, and the Presidents of the Air Industries and Transport Association, the RCAF Association, the Air Cadet League, the Canadian Owners and Pilots Association, the Royal Canadian Flying Clubs Association and the Aviation Writers Association; because it is primarily a C.A.I. affair, Great Britain and the U.S.A. will be represented by the Presidents of the R.Ae.S. and the I.A.S. and the Director of the R.A.E. and the Deputy Administrator of the N.A.S.A. And, of course, His Excellency the Governor-General has honoured us by consenting to be our Principal Speaker.

In addition, the Aerial Experiment Association will be represented by Mrs. Joseph Jones and Mrs. Marston Bates, who are grand-daughters of Dr. Alexander Graham Bell, Mrs. F. W. Baldwin and the Honourable J. A. D. McCurdy, who flew the Silver Dart fifty years ago.

And so this Dinner promises to be, in itself, a memorable event in the history of Canadian aviation. I hope that as many of our members as possible will be there and that non-members who may be interested will not be put off by the impression that this is an exclusively C.A.I. affair. Everyone interested is very welcome to attend.

The Technical Sessions

The Dinner will be commemorative but the technical part of the Meeting will look towards the future. As will be seen from the programme opposite, some very eminent scientists from Great Britain and the U.S.A. will speak to us and the Canadian speakers are also men of great distinction in their respective fields. I feel sure that their survey of the problems confronting us will be as scientific a reading of the crystal ball as any group of papers delivered in recent months.

The Luncheon

Finally, we have the Luncheon on the second day. This is an innovation in C.A.I. Meetings and it is being sponsored by our Astronautics and Propulsion Sections. It too will include an address on a technical subject.

No one can accuse us of a narrow programme or one unworthy of the occasion.

EDUCATION AND TRAINING

I was asked the other day about the Institute's activities in the field of education and training this year. There is not very much to report – at least not very much that I know of. The Provincial Committees of former years are still in being and I understand that their present function is to watch and advise as necessary, without actually taking the initiative in promoting any schemes. The general stir in matters of education which took place a year or two ago resulted in some promising steps being taken (for example, the setting up of three new Institutes of Technology in Ontario) and there is not much we can do while these things are developing. One rather disquieting aspect of the whole business is the increased migration of our graduates south of the border, on account of the unsettled state of the industry in Canada.

SPECIAL ANNIVERSARY MEETING

Programme

February 23rd Morning 9.00 a.m.

ATMOSPHERIC FLIGHT

Chairman

R. D. Richmond
Chief Engineer, Special Weapons
Canadair Limited

Some Technical Aspects of Future Air Travel

Sir George Gardner
Director
Royal Aircraft Establishment

A Canadian View of Recent Trends in Aerodynamic Research

R. J. Templin
Head, Aerodynamics Section
National Aeronautical Establishment

Afternoon 2.00 p.m.

SPACE FLIGHT

Chairman

J. C. Floyd
Vice-President, Engineering
Avro Aircraft Limited

Recent Trends in Aeronautics and Space Research in the United States

Dr. H. L. Dryden
Deputy Administrator
National Aeronautics and Space Administration

Exploration in Space

G. D. Watson
Director, Weapons Research
Defence Research Board

Evening 7.00 p.m.

DINNER

Chairman

Dr. G. N. Patterson
Director, Institute of Aerophysics
President, Canadian Aeronautical Institute

Guest of Honour and Principal Speaker

His Excellency
The Right Honourable Vincent Massey, C.H.
Governor-General of Canada

Special Guest

The Honourable J. A. D. McCurdy

February 24th Morning 9.00 a.m.

SATELLITES

Chairman

Dr. J. J. Green
Canadian Joint Staff, Washington

Satellites and Space Vehicles

D. A. Young
Chief, Space Technology Branch, I.D.A.
affiliated Advance Research Projects Agency

The Contents of Space Near the Earth

Dr. P. M. Millman
Head, Upper Atmosphere Research
National Research Council

Afternoon 12.30 p.m.

LUNCHEON

Chairman

Dr. H. S. Ribner
Institute of Aerophysics
Chairman, C.A.I. Astronautics Section

The Physical Nature of the Planets and their Probable Course of Evolution

Dr. J. F. Heard
Director, David Dunlap Observatory
University of Toronto

Afternoon 2.00 p.m.

PROPULSION

Chairman

F. H. Keast
Chief Engineer
Orenda Engines Limited

Aircraft and Spacecraft Propulsion

A. M. Rothrock
Assistant Director of Research
National Aeronautics and Space Administration

Some Tendencies of Aeronautical Propulsion

Dr. D. C. MacPhail
Director, Div. of Mechanical Engineering
National Research Council

SPECIAL ANNIVERSARY MEETING

Notices giving the full programme of the Special Anniversary Meeting have been sent to all members of the Institute; the programme is also set out on the preceding page.

The following are abstracts of some of the papers to be presented.

Some Technical Aspects of Future Air Travel

Sir George Gardner – R.A.E.

The lecturer will discuss some technical aspects of the cost, convenience, regularity and safety of future air travel.

The effect on the cost and convenience of a number of parameters, such as range, size, speed and VTOL, will be discussed.

Safety will be dealt with by discussing the knowledge gained in the field of structural fatigue and regularity by the example of the work of the Blind Landing Experimental Unit of the Royal Aircraft Establishment.

Finally, some thoughts on future trends will be given.

A Canadian View of Recent Trends in Aerodynamic Research

R. J. Templin – N.R.C.

Recent developments in aeronautics indicate that flight is possible, and in some circumstances may be economically sound, over an extremely wide range of design speeds. A few of these possibilities will be reviewed, including vertical takeoff aircraft which must be capable of hovering flight, and boost glide aircraft which may cruise at speeds which approach satellite velocity.

Some of the aerodynamic research problems which have been raised by these developments will be discussed, with particular reference to possible future Canadian requirements.

Recent Trends in Aeronautics and Space Research in the United States

Dr. H. L. Dryden – N.A.S.A.

The progress of aeronautical research in the United States has again reached a period of reorientation and reassessment as man prepares to venture into space. Supersonic airplanes of ever increasing speed and altitude and long-range ballistic missiles, descendants of subsonic airplanes and artillery projectiles mated to turbojet and rocket engines, have stimulated basic and applied research in broad areas of science and technology. Developments in aerodynamics, propulsion, materials and structures, inertial guidance and electronics have permitted the launching of the first man-made satellites of the earth and high performance aircraft to explore the nearby space environment. Recent trends in research in aeronautics and space will be described.

Exploration in Space

G. D. Watson – D.R.B.

The paper prepared for the special meeting celebrating the 50th Anniversary of Flight in Canada is introduced by contrasting the beginnings of space flight with those for aerodynamic flight. The space environment and its probable effects on space vehicles for terrestial, lunar and interplanetary use; Canadian activities related to space exploration; space science discoveries of importance to Canada; and by-product benefits to other sciences, are discussed along with speculation about probable future developments of space science and space flight.

The Contents of Space Near the Earth

Dr. P. M. Millman – N.R.C.

The contents of space in the terrestrial neighbourhood may be divided into three broad categories – (a) solid objects of dimensions largely relative to the size of atoms, (b) atomic particles such as electrons, atomic nuclei, atoms and molecules, and (c) electromagnetic radiation.

The current state of our knowledge concerning these three categories is reviewed briefly. Information available from ground observations is now supplemented by that obtained from instruments carried in balloons, aircraft, rockets and artificial earth satellites.

Reliable quantitative data concerning the contents of space must be available before the manned space flights of the future can be adequately planned.

The Physical Nature of the Planets and their Probable Course of Evolution

Dr. J. F. Heard – David Dunlap Obs.

We have a reasonably good understanding of the nature of the earth including its interior and its atmosphere. Studies of the nature of other planets, although beset with great observational difficulties, have resulted in a view that the planets came into being as a natural outcome of the sun's birth from cosmic gas and dust. If this view is supported by the improved planetary observations which can be expected soon from space vehicles, then we can conjecture with some confidence concerning the probability of intelligent life elsewhere in the universe.

Aircraft and Spacecraft Propulsion

A. M. Rothrock – N.A.S.A.

The paper discusses the essential factors controlling the performance of propulsion systems for aircraft and spacecraft. Consideration is given to the interrelation between the mission to be performed and the propulsion system type.

An examination is made of the energy sources available in relation to the working fluid or propellant. A summation is made of the fields of research which will result in improved performance and of the difficulties to be overcome in realizing these improvements.

Some Tendencies of Aeronautical Propulsion

Dr. D. C. MacPhail – N.R.C.

From the beginning of powered flight to the present day aircraft have been propelled by many of the available varieties of heat engine. The emphasis on high performance coupled with reliability has led to a remarkable course of development, certain highlights of which are outlined in this paper. Some future aspects are also noted.

SOME OF THE SPEAKERS

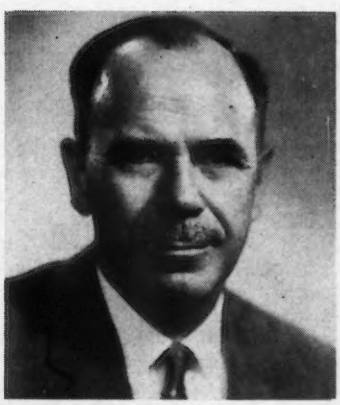
Sir George Gardner

R. J. Templin

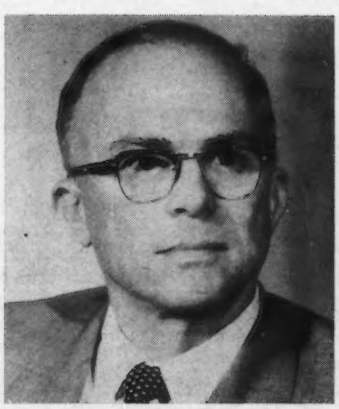
Dr. H. L. Dryden

G. D. Watson

Dr. P. M. Millman



Dr. J. F. Heard



A. M. Rothrock

Dr. D. C. MacPhail

BRANCHES

Vancouver

Reported by G. W. T. Roper

December Meeting

A meeting of the Vancouver Branch was held in the Officers' Mess, RCAF Stn. Sea Island, on the 15th December.

Mr. R. J. McWilliams was in the Chair and 44 members and 12 guests attended.

The speaker of the evening, Mr. H. H. Whiteman, CL 28 Project Engineer for Canadair Limited, was introduced by Mr. A. M. Parry.

Mr. Whiteman chose as the subject of his talk, "The Development of the Canadair Argus". In a talk very amply complemented with slides, the speaker led his audience through the development period, from the time of the initial conception of the specification early in 1954, to its completion in August 1954, through the mock-up approval in January, 1955, the preparation and completion of the engineering releases in May, 1956, and the first flight in March, 1957.

In doing so he gave an adequate description of the aircraft configuration and characteristics, within the limitations of security regulations. Surprisingly little of the original Bristol Britannia design was retained. This was restricted essentially to the wing structure, a major portion of the empennage structure, some features of the landing gear and the surface control systems. Considerable time was devoted to a description of the manufacture and the service flight test programs. Flight test operations will span a period of more than two years from March, 1957, and will total approximately 2,000 hours. These programs will involve eight separate phases and five or six different aircraft.

Against the background of specifications, determination and the subsequent amendments numbering approximately 450, the "Americanization" of some 6,700 Bristol drawings and the associated 52,000 engineering manhours, the design and design substantiation tests totalled 256,000 manhours, in the period of three years from the time of initiation of firm requirements to the time of the first flight, was indeed a very creditable achievement.

Mr. Whiteman ended his talk with the showing of a movie made by the National Film Board on the development of the Argus and entitled "Birth of a Giant".

In the subsequent question and answer period, lasting some thirty minutes, the audience participated in a lively discussion which was terminated by a vote of thanks for the speaker, called for by the Chairman.

The meeting was adjourned at 10.30 pm.

Ottawa

Reported by R. L. Wardlaw

January Meeting

The Branch Chairman, Mr. H. H. Kelland, was Chairman of our meeting on the 14th January. He announced the formation of an Educational Committee within the Branch. It is thought that this is a logical direction in which to broaden the scope of the Branch activities.

Commander N. A. Smith introduced the guest speaker for the evening, Mr. B. A. Avery, the Deputy Chief Engineer of Orenda Engines Ltd. Mr. Avery's subject was "The Mechanical Design and Development Problems of the Iroquois Engine". Mr. Avery briefly outlined the accomplishments of the firm, prior to the conception of the Iroquois in 1953, which resulted in the development of the Chinook and Orenda engines. Starting with the Iroquois intake and working rearward to the engine afterburner, Mr. Avery described in detail the construction and function of the engine components. At the same time, he outlined the development problems that arose, their solutions and the engineering compromises required. The talk was well illustrated with drawings and photographs of the individual components.

It was pointed out that many of the problems arose through the necessity of operating at or beyond the current limits of the "state of the art". This was particularly true with the extensive use of titanium alloys, which at that time were little understood and in a relatively early state of development. The Company has been able to make major contributions in the use of these new alloys.

The talk was followed by a question period and the speaker was thanked for his absorbing and comprehensive outline of the Iroquois development by Wing Commander H. J. M. Londeau.

There was a good attendance at the meeting, 44 members and 6 guests.

Toronto

Reported by E. J. Lynch

December Meeting

The Chairman of the meeting was Mr. W. H. Jackson, Chairman of the Branch. The meeting was attended by a total of 401 persons, of whom 128 were identified as members and 169 as guests.

The speaker, Mr. J. C. Floyd, Vice-President, Engineering, Avro Aircraft Ltd., was introduced by Mr. I. M. Hamer and thanked by Mr. R. B. McIntyre.

Mr. Floyd's talk was a condensed version of the Commonwealth Lecture which he delivered in October before the Royal Aeronautical Society in England. The lecture was illustrated by slides and was followed by the showing of an Avro film entitled "Canada's' Supersonic Sentinel", illustrating the development, construction and flight testing of the Arrow.

Owing to an unfortunate preoccupation with the faulty operation of the film projector, there was no significant discussion of Mr. Floyd's paper.

Business conducted at the meeting was confined to announcements concerning the future program, an appeal to delinquent members to pay their dues, and an appeal to non-members in attendance to consider applying for membership in the C.A.I.

January Meeting

The meeting was held in the De Havilland Cafeteria on the 20th January, commencing at 8.15 pm. The meeting was chaired by Mr. W. H. Jackson and was attended by 51 persons, of whom 10 were identified as guests and 41 as members.

Each of the three speakers was introduced in turn by Mr. Jackson, and Mr. J. P. Uffen thanked the speakers collectively.

The meeting was the occasion of the Toronto Branch Annual Student's Thesis Competition, and the three speakers were finalists who had been selected by the staff of the University of Toronto, coordinated by Dr. I. Glass. The theses were submitted in writing to the panel of judges during the few days immediately before the meeting and were to be finally judged on the basis of the oral presentation as well as their content.

Mr. Y. J. H. Alloucherie spoke on "Dynamics of an Artificial Satellite in an Orbit around the Earth". After deriving equations of the basic conic section orbits which are possible in a frictionless system, he turned to the modifications of theory needed to account for the effects of air drag. The final equations were applied to observations of the change in period of Sputnik 1 per revolution in order to calculate air density at the relevant altitudes, and a reasonable degree of agreement was obtained with other known data.

Mr. K. A. Innanen spoke on "The Lifetimes of Artificial and Natural Earth Satellites". He began with a discussion of basic theory of air drag from a molecule point of view and proceeded to deduce expressions for drag coefficient and air density at specific altitudes. From this he proceeded to calculate the energy loss of a satellite in a circular orbit per revolution, and the resulting reduction of altitude per revolution due to the loss of energy. The resulting equation was then integrated in such a manner as to determine the number of revolutions which might be expected before a satellite would reach the surface of the earth. Some interesting observations were included on the probable lifetimes of two natural satellites which are now known to be in nearly circular orbit around the earth. He then went on to develop a second theory applicable only to elliptical orbits of which a relatively small portion would be subject to atmospheric effects, and an equation was deduced which gave the expected lifetime of such a satellite up to the time when its orbit would degenerate into an approximately circular shape. The prediction of this theory turned out to be in quite close agreement with the observed behaviour of a number of artificial satellites.

Mr. J. G. Laframboise spoke on "Aerodynamics of Bodies in Free Molecule Flow'". This type of flow must be considered for typical satellites and for vehicles which may substantially leave the atmosphere temporarily, and it may be considered to be in effect when the ratio of the mean free path of atmospheric molecules to a typical dimension of the flight body (Knudsen number) exceeds about two. It was shown that the reflection of air molecules from the body surfaces is principally diffuse and not specular, and by means of the principles involved in the kinetic theory of gases, expressions were developed for the normal and shear forces exerted by the gas on the body under conditions of diffuse reflection. While the resulting equations were difficult in form, the application of practical values of the parameters involved resulted in a number of terms approaching closely to limit values, and it proved that the theory could be used satisfactorily for altitudes in excess of approximately 90 miles. It would be of limited usefulness, however, at the altitudes of approximately 50 miles at which most satellites appear to burn and, therefore, cannot be used with any accuracy to determine probable satellite lives. Illustrations were given of the application of the theory to determine minimum drag shapes for given volumes at the altitudes where the theory was applicable.

The panel of judges consisted of Dr. J. H. T. Wade, Aerodynamics Specialist, Orenda Engines Ltd., Mr. W. Czerwinski, Chief of Preliminary Design, Avro Aircraft Ltd., and Dr. P. A. Lapp, Project Engineer, De Havilland Aircraft of Canada Ltd. Dr. Wade acted as Chairman of the panel and commented upon the theses before announcing the decision of the judges. Judgment was made on the basis of the manner of presentation, adherence to the time allowed, the organization of the material and the originality and extent of coverage. Mr. J. G. Laframboise was awarded first prize, and Messrs. K. A. Innanen and Y. J. H. Alloucherie were awarded the remaining two prizes on an equal basis.

Certificates of merit and prize cheques were presented to the three contestants by Mr. W. Jackson, who announced that the bronze medallion would be presented to Mr. Laframboise on the occasion of the Branch Annual Dinner Meeting in April.

Earlier in the meeting, a short account was given by Mr. J. A. Stein, Chairman of the Toronto Branch Student Awards Committee, of plans for extending the student award scheme, and it was announced that the scheme would be extended to the Ryerson Institute of Technology and the Central Technical School in Toronto, during the present academic year.

Cold Lake

Reported by WO2 J. W. Day

January Meeting

Eighty members and guests attended the meeting held on the 12th January, 1959, under the Chairmanship of F/L L. S. Lumsdaine.

The speaker was Mr. P. L. E. Gallimore of Avro Aircraft Ltd., who spoke on the "CF-105 Arrow All Weather Fighter". It was a very interesting paper, though for security reasons the speaker was unable to give any official data.

In discussing the design and development aspects, Mr. Gallimore pointed out that Avro used the new technique of producing production drawings and tooling up for production for the very first aircraft. This enabled a very rapid transition from the prototype to the production state. Mr. Gallimore also described the testing of models in wind tunnels and free flight, which formed an important part of the initial research.

In considering operational aspects, problems associated with the speed, range, altitude and time to turn around were discussed – these problems being the subject of close study by Avro and the Air Force. The Arrow Ground Support equipment (GHE) must be very extensive.

Under the heading of maintenance, Mr. Gallimore referred to the many trades involved and their relative responsibilities. He also pointed out how care had been taken in the design to insure accessibility for replacement purposes so far as possible.

In closing, a film "Supersonic Sentinel" was shown, depicting the plant operations, design, testing and finally the flight of the CF-105.

Following an informal discussion, the speaker was thanked by W/C W. N. Hoye.

Edmonton

Reported by J. G. Portlock

January Meeting

The fifth meeting of the Edmonton Branch was held at the RCAF Association, 700 Wing Mess, at 8.00 pm on the 14th January, 1959.

In the absence of the Branch Chairman, Mr. J. G. Portlock presided and welcomed 26 members and 29 guests to the meeting.

The Secretary read the Minutes of the December meeting and it was proposed by Mr. C. W. Arnold and seconded by F/O K. Weinstein that they be adopted as read.

There being no business to discuss, the meeting was turned over to the Programme Chairman, F/O A. Robinson, who presented as his first item an excellent Shell colour film entitled "Transonic Flight". This film was much enjoyed by all present and is one highly to be recommended for the attention of aeronautical engineering students.

After the showing of the film, F/O Robinson introduced the guest speaker, Mr. P. L. Gallimore of Avro Aircraft Ltd., who was to speak on "The Development and Operation of the CF-105".

Mr. Gallimore then spoke for an hour on some of the main aspects of the design, building and flight testing of the CF-105, including the wind tunnel and

free flight model testing programme. He stressed the fact that many design problems encountered in the Arrow were new problems, which had to be solved by the Avro team with what help they could get from the parent company and from the N.A.C.A. The location and design of the wing notch was typical of the many problems which had to be solved. On the construction side, Mr. Gallimore spoke of the new equipment and machines which had to be installed for the production of the various components, particularly the machine for milling wing skins with integral stiffeners. On the testing side, he mentioned the many test rigs and simulators which were constructed for the functional testing of components and systems. The test pilots were part of the testing programme at a very early stage and spent many hours in the test rigs, becoming familiar with the operation of the various controls and studying the behaviour of systems in simulated flight conditions.

Mr. Gallimore then ended his talk and presented a film entitled "The First Flight of the Arrow", in which many of the points mentioned in his talk were illustrated. The film was beautifully produced in colour and was much enjoyed.

The speaker was then thanked by Mr. Portlock and the meeting was adjourned.

MEMBERS

NEWS

C. W. Lemmerman, A.F.C.A.I., has been elected President of the Connecticut Valley Section of the American Rocket Society.

H. St. L. Dannatt, M.C.A.I., formerly with Canadair Ltd., has joined Remington Rand Univac, Div. of Sperry Rand Corp., as a Senior Engineer.

J. C. Howlett, M.C.A.I., has left Orenda Engines Ltd. to take up a position as Technical Writer with Boeing Airplane Co., Seattle.

F. M. Hurst, M.C.A.I., has returned from England where he was employed by Rotol Ltd., to take up a position with Rotol Inc., Arlington, Va.

W. J. H. West, M.C.A.I., is leaving Canadair Ltd. for a year's assignment with Boeing Airplane Co., Seattle.

W. A. Foote, Technical Member, has left Avro Aircraft Ltd. to take up a position with Okanagan Helicopters Ltd., Vancouver.

F/L D. A. Fretts, Technical Member, has been transferred from the CEPE Det. at Pt. Mugu, Calif., to the Air Armament Evaluation Detachment at Cold Lake, Alta., as Officer in charge of Airborne Instrumentation and Environmental Testing.

DEATH

It was with deep regret that we learned of the death in January of **P. F. Strong, M.C.A.I.,** who was Office Supervisor, Commercial Aircraft Dept., Northwest Industries Ltd.

ADMISSIONS

At a meeting of the Admissions Committee, the following were admitted to the grades shown, effective 2nd January, 1959.

Associate Fellow

I. G. Gray, Supervisor of Flight Test, Special Weapons Engr., Canadair Ltd., Montreal, P.Q.: *11829 St. Evariste St., Montreal 9, P.Q.*

W. J. Rainbird, Design Engineer (Aerodynamics), Defence Research Board, Ottawa, Ont.: *78 Presland Rd., Ottawa, Ont.*

Dr. P. Savic, Senior Research Officer, National Research Council, Ottawa, Ont.: *Box 245, R.R. No. 1, Ottawa, Ont.*

Member

L. Badone, Section Chief, Metallurgical Dept., Avro Aircraft Ltd., Malton, Ont.: *34 Avondale Blvd., Willowdale, Ont.*

S/L R. M. Bauman, RCAF, Inspector of Accidents, AFHQ, Ottawa, Ont.: *2033 Saunderson Dr., Ottawa, Ont.*

D. M. Croker, Service Engineer, Orenda Engines Ltd., Malton, Ont.: *23 Harrow Dr., Toronto 15, Ont.*

L. M. Cudney, Supervisor, Technical Service, Canadair Ltd., Montreal, P.Q.: *93 Prince Edward Ave., Valois, P.Q.*

R. H. Dalley, Air Electrical Officer, HMCS Stadacona, Halifax, N.S.: *33 Morris Ave., Shearwater, N.S.*

F. A. Danby, Training Instructor, Engineering Div., Avro Aircraft Ltd., Malton, Ont.: *5 Formica Rd., Toronto 15, Ont.*

D. F. Daw, Asst. Research Officer, National Research Council, Ottawa, Ont.: *Box 514, R.R. 2, Ottawa, Ont.*

LCDR (E) E. R. Forster, RCN, Deputy Director of Naval Flight Safety: *81 Newcastle St., Dartmouth, N.S.*

H. M. Franklin, Chief Inspector, Chinook Flying Service Ltd., Calgary, Alta.: *226 - 13 Ave. N.W., Calgary, Alta.*

P. B. French, President, Philip French Sales Ltd., 8425 Mountain Sights Ave., Montreal 16, P.Q.

V. G. Gibbard, Tech. Representative, Orenda Engines Ltd., Malton, Ont.: *4 Erlesmere Ave., Brampton, Ont.*

K. B. Gilmore, Supervisor, Tech. Services, Canadair Ltd., Montreal, P.Q.: *115 Gagnon St., St. Rose, Co. Laval, P.Q.*

D. Jones, Senior Engineer, Canadair Ltd., Montreal, P.Q.: *23 Terrasse Pesant, St. Dorothee, Montreal, P.Q.*

W. P. Kieran, Special Representative, Aviation Products, Goodyear Tire & Rubber Co., 2050 Cote de Liesse Rd., Town of Mount Royal, P.Q.

S/L G. Kreklewetz, RCAF, Tech/AE, AFHQ, Ottawa, Ont.: *875 Hemlock Rd., Ottawa, Ont.*

J. A. Love, Chief Inspector, Lucas-Rotax Ltd., Vancouver Airport, B.C.

R. I. Mackenzie, Field Service Representative, Canadair Ltd., Montreal, P.Q.: *c/o Officers' Mess, RCAF Stn. Namao, Alta.*

J. E. Mailman, Asst. Plant Manager, Fairey Aviation Co. of Canada Ltd., Dartmouth, N.S.: *79 Johnstone Ave., Dartmouth, N.S.*

Dr. H. M. McMahon, Defence Scientific Services Officer, Canadian Armament Research & Development Establishment, Aerophysics Wing, P.O. Box 1427, Quebec, P.Q.

J. F. McMahon, President, Western Airmotive Ltd., Vancouver Airport, B.C.

W. J. Riley, Chief Engineer, Sperry Gyroscope Co. of Canada Ltd., P.O. Box 710, Montreal, P.Q.

H. Robertson, Design Checker, Avro Aircraft Ltd., Malton, Ont.: *299 Brooke Ave., Toronto 12, Ont.*

C. H. Scoons, Process Planner, Prod. Engineering, Avro Aircraft Ltd., Malton, Ont.: *2 McCulla Ave., Brampton, Ont.*

WO2 D. M. Scott, RCAF, Aircraft Maintenance Superintendent, RCAF Stn. Cold Lake, Alta.: *Box 1201, RCAF Stn. Cold Lake, Alta.*

Lt. (L) H. W. Smith, RCN, Electrical Course, HMCS Stadacona, Halifax, N.S.: *23½ James St., Dartmouth, N.S.*

Cmd Amn (SE) D. A. Young, RCN, Staff Officer Safety Equipment, NDHQ, Ottawa, Ont.: *415 Brittany Dr., Ottawa, Ont.*

Technical Member

F/L A. J. Anderson, RCAF, Test Pilot, RCAF Stn. Cold Lake, Alta.: *c/o Officers' Mess, RCAF Stn. Cold Lake, Alta.*

PO K. D. Connolly, RCN, Air Technician, HMCS Shearwater, N.S.: *11 Gladstone Ave., Dartmouth, N.S.*

W. O. Crabtree (on transfer from Technician)

L. J. Dickinson, Aircraft Production Planner, Bristol Aircraft (Western) Ltd., Winnipeg, Man.: *907 Centennial St., Winnipeg 9, Man.*

LCDR (P) W. H. Frayn, RCN, Commanding Officer, Helicopter Utility Sqdn. 21, RCNAS Shearwater, N.S.: *Box 97, Shearwater, N.S.*

B. Glynn, Asst. Test Supervisor, Jarry Hydraulics, Montreal, P.Q.: *3015 Bedford Rd., Apt. 12A, Montreal P.Q.*

A. L. Hunt, Instrumentation Technician, Computing Devices of Canada Ltd., Ottawa, Ont.: *2530 Place Monceau, Sillery, P.Q.*

P. W. S. James, Performance Engineer, Lucas-Rotax Ltd., Scarborough, Ont.: *130 Perivale Cresc., Scarborough, Ont.*

L. S. Jani, Sr. Plant Layout Planner, Canadian Pratt & Whitney Aircraft Co. Ltd., Montreal, P.Q.: *3300 Ridgewood Ave., Apt. 30, Montreal, P.Q.*

J. A. M. Kennerley, Aerodynamicist, Canadian Pratt & Whitney Co. Ltd., Montreal, P.Q.: *10 Oldfield, Apt. 1, Montreal, P.Q.*

E. E. Knowler, Sub Foreman, Canadian Pacific Airline (Repairs) Ltd., RCAF Stn. Lincoln Park, Calgary, Alta.: *1316 - 1st St. N.W., Calgary, Alta.*

S. W. Knowles, Technician Air, DND/DAE (Navy), Ottawa, Ont.: *290 Gloucester St., Apt. 7, Ottawa, Ont.*

R. M. Legge, Service Engineer, Avro Aircraft Ltd., Malton, Ont.: *84 Wolverleigh Blvd., Toronto 6, Ont.*

R. W. Lewin, Crew Chief, Northwest Industries Ltd., Edmonton, Alta.: *11133 - 129 St., Edmonton, Alta.*

R. R. Luna, Service Engineer, Boeing Airplane Co., Seattle, Wash.: *823 Madison Ave., Seattle, Wash.*

J. H. N. Pierce, District Manager, Whiting Corporation (Canada) Ltd., Welland, Ont.: *31 Parkland Ave., Valois, P.Q.*

Sgt. H. Richardson, RCAF, Supervisor Airframe Technician, RCAF Stn. Cold Lake, Alta.: *c/o Sergeants' Mess, RCAF Stn. Cold Lake, Alta.*

S/L G. L. Sheahan, RCAF, Editor of Flight Comment, AFHQ, Ottawa, Ont.: *48 Byron Ave., Ottawa, Ont.*

H. A. Talbot (on transfer from Associate)

E. Taylor, Tool Planning Engineer, Canadair Ltd., Montreal, P.Q.: *11835 General Giraud, Apt. 1, Cartierville, Montreal, P.Q.*

Junior Member

S/Lt. (E) (AE) G. S. Moyer, RCN, Engineering Dept., HMCS Shearwater, N.S.: *Wardroom, HMCS Shearwater, N.S.*

Student

J. H. Fine, University of Toronto, Toronto, Ont.: *3240 Bathurst St., Apt. 304, Toronto 19, Ont.*

J. G. Laframboise, University of Toronto, Toronto, Ont.: *Box 184, St. Michael's College, Toronto 5, Ont.*

J. Liiva, University of Toronto, Toronto, Ont.: *48 Garnock Ave., Toronto 6, Ont.*

H. Magiso, University of Toronto, Toronto, Ont.: *9 Dingwall Ave., Toronto 6, Ont.*

F/C A. Proulx, McGill University, Montreal, P.Q.: *1656 Champigny St., Montreal 20, P.Q.*

A. A. Sonin, University of Toronto, Toronto, Ont.: *4 Playter Cresc., Toronto 6, Ont.*

R. C. Tennyson, University of Toronto, Toronto, Ont.: *15 Barrington Ave., Toronto 13, Ont.*

Associate

N. J. Armstrong, Manager, Western Division, Spartan Air Services Ltd., Calgary, Alta.: *923 - 36th St. N.W., Calgary, Alta.*

APPOINTMENT NOTICES

The facilities of the Journal are offered free of charge to individual members of the Institute seeking new positions and to Sustaining Member companies wishing to give notice of positions vacant. Notices will be published for two consecutive months and will thereafter be discontinued, unless their reinstatement is specifically requested. A Box No., to which enquiries may be addressed (c/o The Secretary), will be assigned to each notice submitted by an individual.

The Institute reserves the right to decline any notice considered unsuitable for this service or temporarily to withhold publication if circumstances so demand.

Mechanical Engineer: To supervise small precision machine shop. Must have (a) Higher National Certificate, or equivalent; (b) 20 years' practical experience in small organization and fully conversant with aircraft materials and standards; (c) ability to estimate and process machinery operations; (d) design and supervise manufacture of jigs and fixtures; (e) drive and ability. Apply in writing to the General Manager, Canadian Flight Equipment Cobourg Ltd., 66 Swayne St., Cobourg, Ont.

SUSTAINING MEMBERS

NEWS

Avro Aircraft Ltd. completed production of the last CF-100 on the 4th December. A brief ceremony was held as the aircraft was moved out of the production bay onto the flight line.

The prototype CF-100, Mk. 1, first flew in January, 1950. In all, a total of 692 of these aircraft were built.

Canadian Applied Research Ltd. announce the introduction of their Ice Detector Test Set, Type T272, Mk. 2. This portable unit was designed to facilitate the testing of Ice Detectors manufactured by the company.

CARL's new Test Set is used for testing the Ice Detection System installed in an aircraft or on the bench. When used for installation tests, the Test Set can detect faults in the associated aircraft electrical wiring in addition to its normal function.

Basically, the Test Set provides a controlled source of vacuum or pressure which can be applied to the Ice Detector on test, to simulate the pressure changes which occur within the unit when icing conditions are encountered.

The Test Set's extremely low weight of 9 lb is achieved by housing all components in a portable waterproof aluminum case measuring 16 in × 10 in × 8 in. The case accommodates a panel on which are mounted the operating controls and components of a vacuum gauge assembly. Adjacent to the panel are two compartments, one housing the cable assemblies used for testing and the other containing attachment clips for two expendable probe refrigerant containers for use when the ambient temperature is above 40°F. Refrigerant is sprayed on Ice Detector probe tips prior to testing where access to the unit test switch is restricted.

Interpretation of the functioning of the Ice Detection System is performed by connecting a multimeter to the Ice Detector signal pin and ground. By noting the readings on the vacuum gauge when the icing signal appears, the serviceability of the System may be established.

Canadair Ltd. has announced the receipt of a contract from the Boeing Airplane Co., Seattle, Wash., for engineering services in connection with the U.S. Bomarc Missile Program.

Under the contract, the Company is sending some 180 engineers and scientists to assist Boeing in speeding into operational service the advanced Model 'B' of the Bomarc missile. These men will continue to be employed by Canadair and they in no way lose their Canadian identity in work assignments with Boeing personnel. The men will be paid by Canadair and will return to the company at the expiration of the contract which extends through December 31, 1959, but can be extended by mutual agreement. Canadair is reimbursed by Boeing for the engineering services provided by the Canadians.

All the Canadair specialists volunteered for the Boeing assignment.

The work of the "lend-lease" engineers is in virtually all fields associated with missile development and operation. The largest group — 102 engineers and scientists — will work in Seattle on design and analytical elements of the program. The Bomarc target-seeker group, flight control, stress, applied physics, system performance, electrical power, hydraulic control, autopilot and base design are typical of the units in which these engineers are assigned.

The test phase of Bomarc operation is the task of 61 of the Canadians. Many of these men are assigned to Florida in Bomarc firing activities. They will serve as firing engineers, data system designers, telemetry engineers and weapon control equipment specialists, to name just a few of the assignments.

Engineering phases of production work round out the duties of the remainder of the Canadians. Tool planning, quality control and manufacturing liaison are typical of the responsibilities in these areas.

Dowty Equipment of Canada Ltd. announces that their parent company, Dowty Group Ltd. of England, has acquired two British companies, Rotol Ltd. and their subsidiary British Messier Ltd. Both of these companies, which are located near the Dowty Group's headquarters in Cheltenham, were formerly owned jointly by Rolls-Royce Ltd. and the Bristol Aeroplane Company Ltd. It is expected that this acquisition will be reflected in the work of the Canadian Company, since both Rotol and British Messier products are already in operation in this country.

Computing Devices of Canada Ltd., the Canadian licensee of the Decca Navigator, has announced that BOAC will install the Decca/Dectra Navigation System in their new fleet of Comet 4 aircraft.

Decca is a high accuracy, area coverage navigation system which shows the geographical position of an aircraft continuously by tracing an inked line on a moving chart. Dectra is a long-range version capable of providing accurate position information across the Atlantic.

Decca, which is accurate for short ranges (up to about 350 miles), was first used by the Royal Navy on D-Day in 1945 and is now fitted in nearly 5,000 ships and aircraft in Europe and North America. A fixed pattern of electronic "position lines" is laid down by chains of ground transmitters and interpreted by special receivers to provide accurate, continuous position information. Chains of ground stations provide coverage over most of western Europe and four chains in eastern Canada provide Decca coverage from east of Newfoundland to Montreal.

Two transmitters in Newfoundland and one in Scotland provide the Dectra coverage across the Atlantic. The Canadian installations are operated by Computing Devices of Canada Ltd.

Evaluation of Dectra over the past 18 months has been carried out by the British Ministry of Supply and by a number of civil airlines in addition to BOAC. Pan American World Airways Inc. reported that "Dectra . . . was found to be reliable, highly accurate, simple to operate, and provided a new aspect to the presentation of navigational fixing through Flight Log. The accuracy of Dectra was found to be superior to the standard navigational systems against which it was checked. Dectra was found to be almost unaffected by precipitation static and continued to function when all other radio reception was swamped out."

Major advantage claimed for the Decca/Dectra system is that it will provide an adequate number of defined flight paths enabling full use to be made of the air space to allow the rapidly increasing numbers and types of aircraft to operate safely and efficiently in their desired altitude levels. Flight at an optimum altitude is especially important for jet aircraft; a typical jet consumes an additional 1,000 lb of fuel an hour for each 4,000 ft deviation from its optimum altitude. A 2,000 ft "stepped" climb to cruising altitude between London and Gander could cost the equivalent in weight of 5 passengers due to these additional fuel requirements.

Jarry Hydraulics, formerly a division of Jarry Automobile Ltée, has been incorporated as Jarry Hydraulics Ltd.

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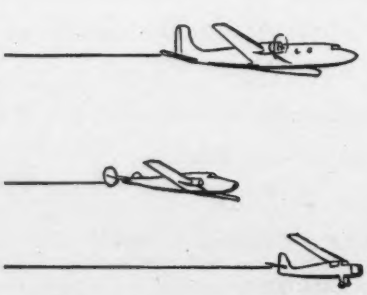

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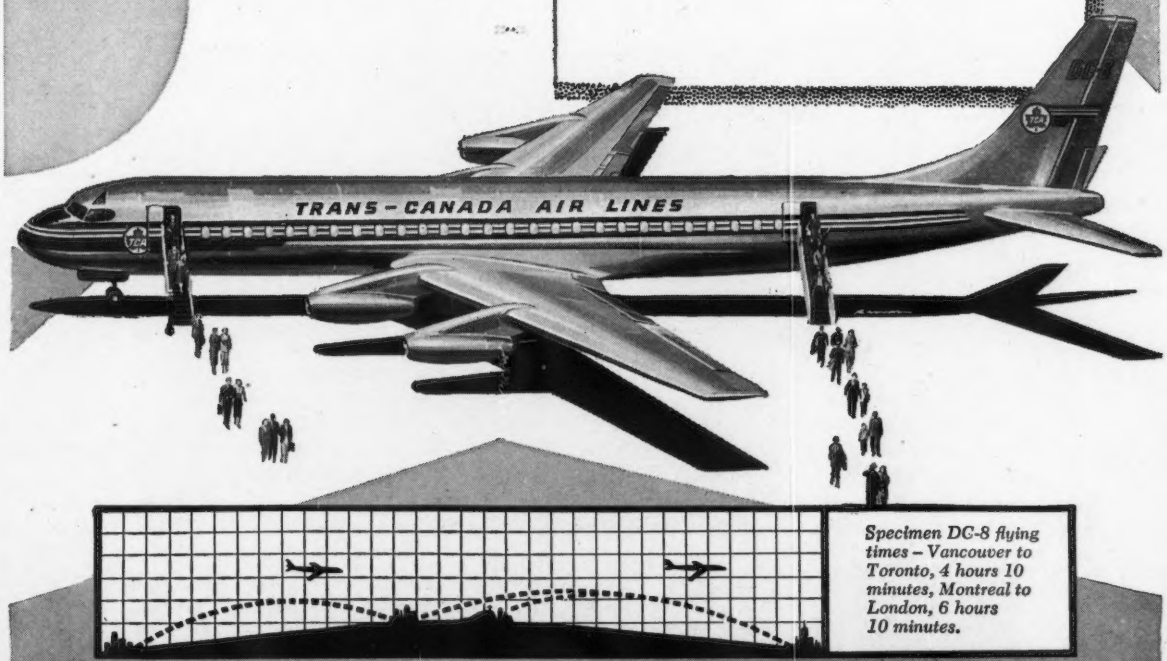

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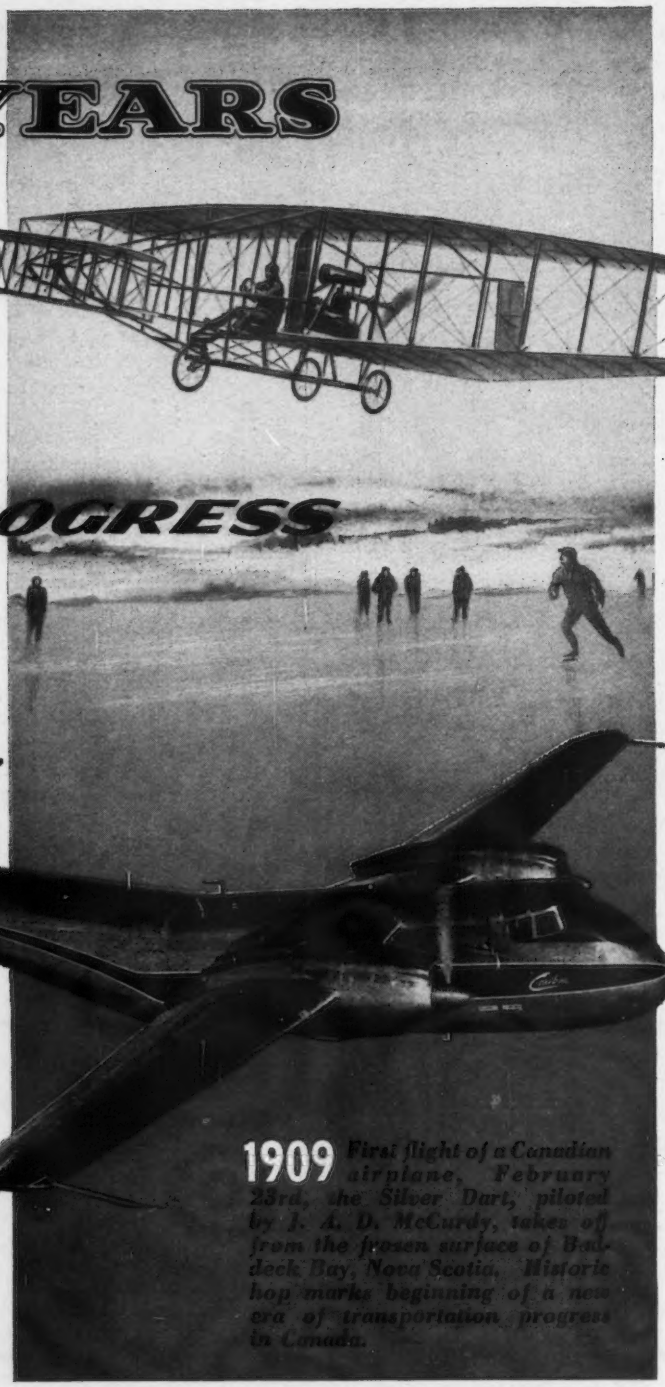

1909 *First flight of a Canadian airplane. February 23rd, the Silver Dart, piloted by J. A. D. McCurdy, takes off from the frozen surface of Baddeck Bay, Nova Scotia. Historic hop marks beginning of a new era of transportation progress in Canada.*

1959 ***First delivery in February of a de Havilland Canada DHC-4 Caribou at Downsview, Ontario. Fifty years after the Silver Dart, the Caribou — the first STOL aircraft in its weight category (24,000 lbs.) — ushers in a new era of cargo/passenger air service to the remote areas of the world.***

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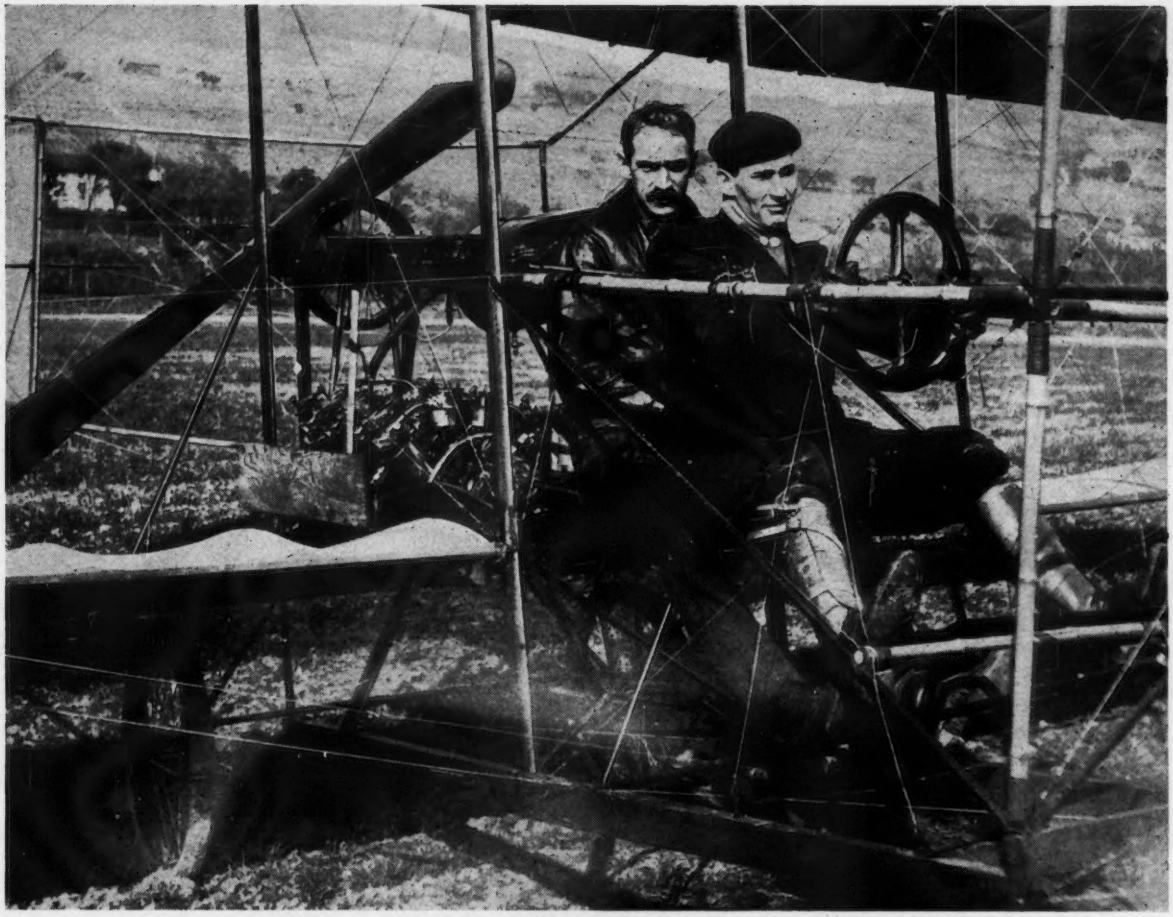

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HISTORICAL BEGINNING OF CANADA–U.S.A. TEAMWORK

Canada's first powered flight made 50 years ago by the Silver Dart marked the beginning of close cross-the-border teamwork between Canada and the United States. This teamwork over the past half century has achieved many 'firsts' in aviation history important to both countries.

McCurdy's Silver Dart was the remarkable achievement of that first Canadian-U.S. team, Alexander Graham Bell's Aerial Experiment Association. Designed and built in the United States by Canadian John A. D. McCurdy (pictured above, wearing cap, in the Silver Dart with the U.S.A.'s Glenn Curtiss, designer of the plane's water-cooled engine), this historical aircraft was shipped to Canada to make history at Baddeck, Nova Scotia, in 1909: the first flight in the British Commonwealth made by a British subject (McCurdy).

Since that time, cross-the-border cooperation between the two countries has played an important part in Canada's contribution to aeronautical progress. The Garrett Manufacturing Corporation of Canada, Limited, as a major supplier of equipment for most of Canada's aircraft, is proud of this contribution. With complete design, laboratory and manufacturing facilities in both Canada and the United States, The Garrett Corporation is developing many types of equipment for specific requirements of both countries and looks forward with greater zeal than ever before to contributing to the advancement of flight on both sides of the border.

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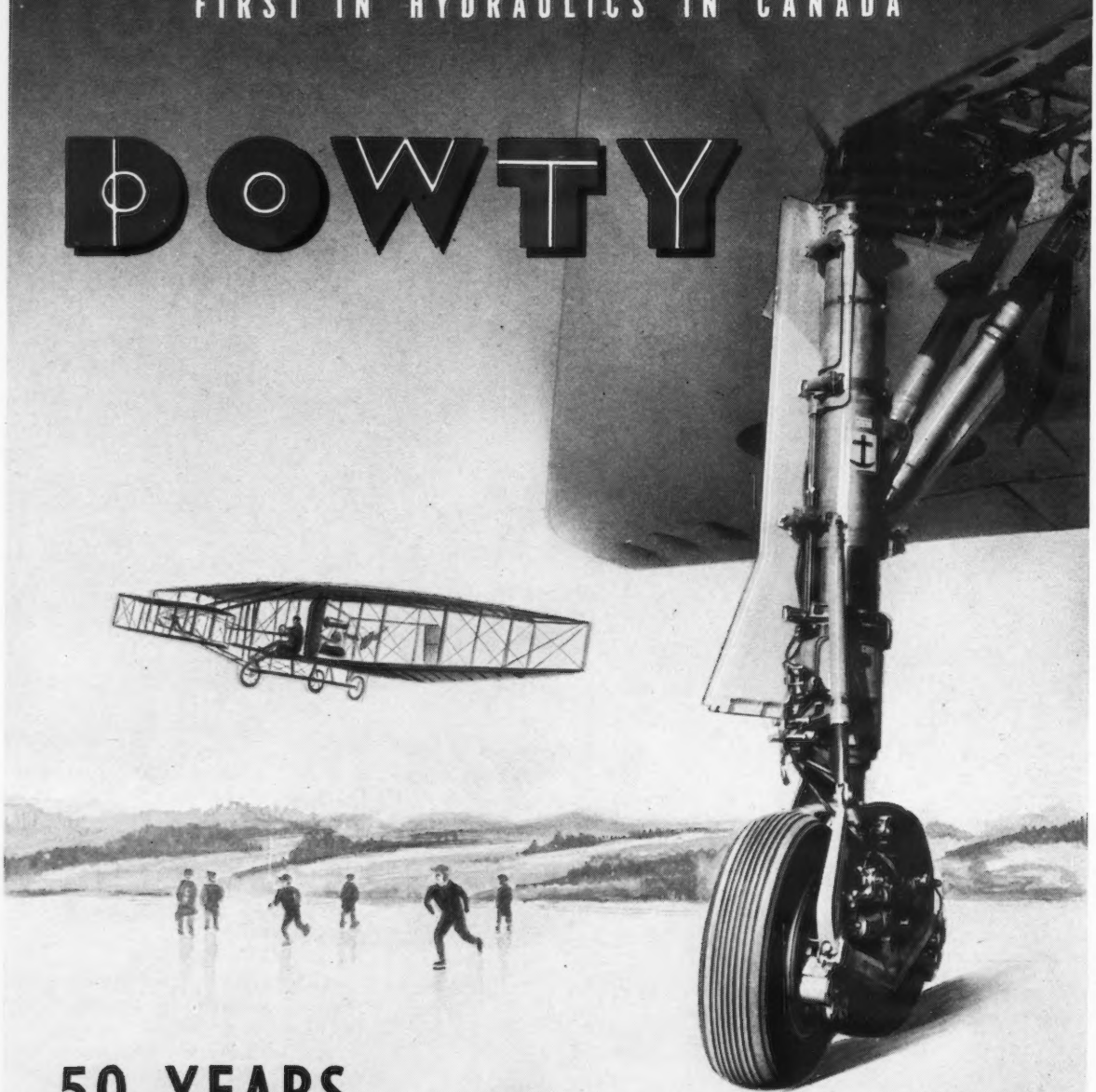

50 YEARS
of CANADIAN FLIGHT

DOWTY, now in its twenty-first year of continuous operation in Canada, is proud to have played a part in the first fifty years of the nation's aeronautical progress.

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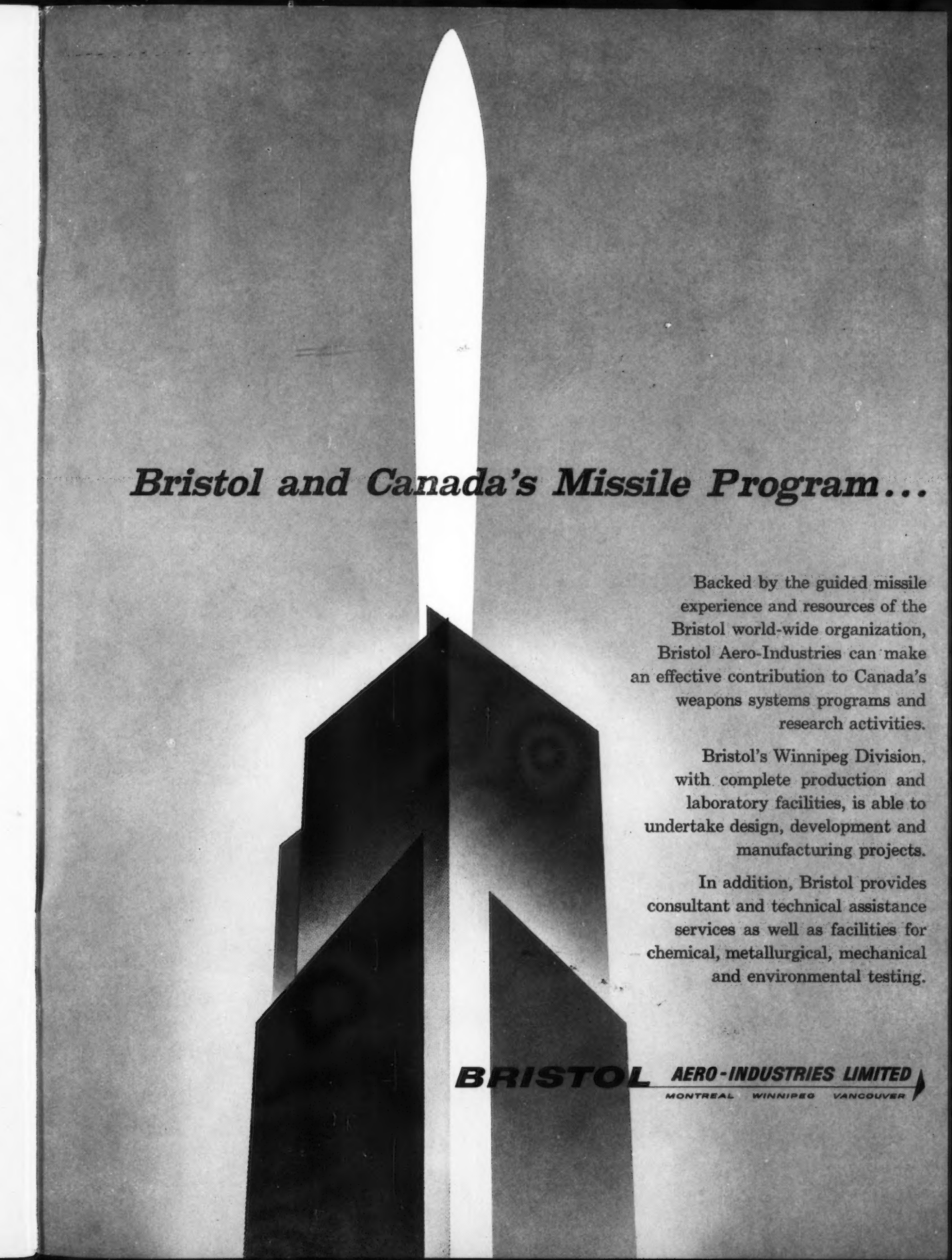

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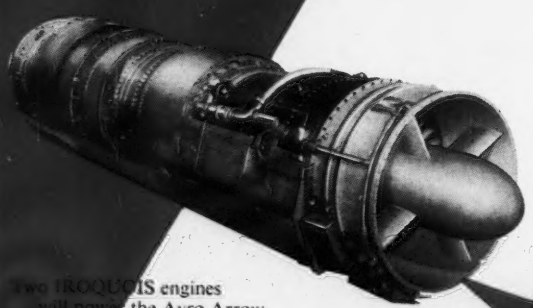
Golden Anniversary of FLIGHT IN CANADA

IT HAPPENED FIRST AT BADDECK, N.S....



Two IROQUOIS engines will power the Avro Arrow

On Feb. 23, 1909, a 35-horsepower, eight cylinder piston engine powered McCurdy's 'Silver Dart' on the first official flight in the British Commonwealth.

Today, less than a lifetime later, over 60,000 horsepower in Orenda's IROQUOIS turbojet—an engine six times the combined weight of the 'Silver Dart', its engine, pilot and fuel.

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